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ORIGINAL MEMOIRS.

TESTING THE EFFICIENCY OF THE COLLATERAL CIRCULATION AS A PRELIMINARY TO THE OCCLUSION OF THE GREAT SURGICAL ARTERIES.*

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I.

THE surgery of the vascular system bristles with problems which still await solution, but none appear to me more important or fundamental than the study of the collateral circulation in its behavior to occluded arteries and in the means of testing its efficiency or inefficiency before permanently obstructing the more important arterial channels of the circulation.

It must be apparent to all surgeons who have kept abreast of the great and phenomenal advances which experimentation in the laboratory and in the clinic have recently brought about in the treatment of the surgical diseases of the blood-vessels, that the general principles which have hitherto governed the treatment of the accessible surgical aneurisms must soon undergo revision. It must be conceded, to begin with, that the classic principle, that a diseased aneurismal or injured

* The President's address at the meeting of the American Surgical Association, June, 1910.

artery could only be made safe by the suppression of its blood-carrying function, whether by ligation, extirpation, or other means of obliteration (Scarpa), is rapidly yielding to the better appreciation of the true surgical ideal, which is to cure, if possible, without the suppression of the vascular function.

The need of preserving the function of the great vascular trunks, especially the great arteries at the root of the limbs, of the neck, and of the viscera, and the obvious dangers which attend their surgical obliteration have always been apparent to surgeons. But the fear of obliterative thrombosis and secondary hemorrhage and the difficulties of the technic by which the continuity of the vessel can be restored are even now so grave an obstacle in the way of the accomplishment of the ideal, that, in spite of the vast increase in the surgical resources by which this *restitutio ab integro* may be accomplished, many among us, even the most skilful, are led to follow the old beaten path, with its easy methods of obliteration, and trust to nature and the collateral circulation to supply the blood deficient in the suppressed area.

Were it possible in every given instance to determine, before undertaking an intervention, that the suppression of the blood-vessel under consideration would certainly and inevitably terminate in a fatal ischæmia and necrosis of the dependent territory, either the intervention would not be undertaken or the operator would, in doing so, prepare to avail himself of every method suggested by which the preservation of the main channel of the circulation could be assured. It is in the treatment of the peripheral aneurisms, whether of traumatic or pathologic origin, which involve the great arterial trunks at the root of the limbs or in the neck (especially those of the neck and lower extremities), that the desirability and utility of a test, by which the adequacy or inadequacy of the collateral circulation, *ante-operationem,* may be determined, is most keenly and urgently felt.

It is true that in the lower animals, which are practically free from arterial disease or degenerative cardiac lesions, all the arteries, including the thoracic and the abdominal aorta

below the renals, can be ligated with comparative impunity. It is also true, and for the same reason, that in children and young subjects with normal hearts and blood-vessels, the inherent capacity of the heart and vascular system for accommodation to the most variable and unexpected demands is quite sufficient to overcome the resistance of the undeveloped collateral routes, when obstacles are put in the way of the circulation even of the larger central and root trunks. But it is otherwise in adults or in the aged who have lost the elasticity and contractility of their arteries; in those who by congenital defects or anomalies in the distribution of the vessels (seemingly far more common in man than in the lower species); and, again, in all those who are suffering from acquired arteriosclerotic and obliterative processes, and with poorly nourished or otherwise defective hearts, there is a failure to provide the needed *vis a tergo* which is required to overcome the increased peripheral resistance. In this last category must be placed a large number of the victims of the pathological or so-called spontaneous aneurisms; the aneurism itself furnishing the most striking evidence of the underlying vascular cachexia.

While it is true that many individuals who bear the unmistakable stigmata of cardiovascular disease have been operated upon for aneurism and other vascular lesions by methods which suppress large arterial tracts, and have survived the ordeal without menace to life or limb; and while it is also true that by the direct and conservative methods of intra-aneurismal obliteration, which I have advocated so persistently during the last eight years, the number of necroses has been surprisingly small, considering the relatively large number of observations that have accumulated up to the present time, it is nevertheless true that in a certain percentage of cases the obliteration of a large surgical trunk, even in a very restricted area, will determine the death or fatal degeneration of the parts or regions supplied by it. It is, therefore, highly important and urgent that some satisfactory test or method be devised by which the indications for operation in any given case may be met, or at least anticipated.

As long as this is not done, the surgical treatment of aneurism will have to be conducted on an empiric basis, even as it is at present. We should not trust to chance, but we should know, with some approach to certainty, whether in any given case the main artery of a limb may be suppressed with impunity or it may not. If we are facing a femoral or a popliteal aneurism, how much more confidently we would attack it if we had a reasonable assurance beforehand that the life in the foot would be preserved even after the main trunk had been occluded at the aneurismal site!

While fully convinced that every peripheral aneurism involving a large arterial trunk should be approached from the operative side, with a fixed determination to preserve the parent trunk while suppressing the sac, experience clearly shows that this is impracticable in many instances, or that extraordinary measures, which may still be classed as uncertain, adventurous, or heroic (venous and arterial transplantations, arterioplasties, patching of arteries, etc.), may have to be resorted to if such a restoration is attempted.

What has been done to help the surgeon in determining the adequacy or inadequacy of the circulation, thereby furnishing a rational basis for the classification of his aneurisms from the operative point of view? Strangely enough, comparatively little attention has been given to this phase of the aneurismal question up to the present time.

In my paper on the statistics of endo-aneurismorrhaphy, read before the Surgical Section of the American Medical Association, at the Chicago meeting, June, 1908, I analyzed the reports of 85 operations performed by this method. Since that meeting, the statistics of the intrasaccular method have increased to 145. Of these, 127 involved the great trunks of the lower extremities from the iliac to the posterior tibials—the real testing ground of the operative treatment of the accessible or peripheral aneurisms. These statistics include up to the present time (April 29, 1910), 90 popliteal, 26 femoral, 2 external iliac, 7 iliofemoral, and 2 gluteal aneurisms. Combining the statistics published in 1908 (85 cases) with the

unpublished series of new cases which have been reported from June, 1908, to April 29, 1910 (60 cases), we find the total 145 cases may be grouped into the three operative types of endo-aneurismorrhaphy as follows:

1. Obliterative group (old).....	59	
Obliterative group (new).....	46	
	105	105 (72.4 per cent.)
2. Restorative group (old).....	13	
Restorative group (new).....	7	
	20	20 (13.7 per cent.)
3. Reconstructive group (old).....	13	
Reconstructive group (new).....	7	
	20	20 (13.7 per cent.)
	145	

[Since April, 1910, 4 more reconstructive operations (all successful) have been reported in the femoropopliteal tracts by Dr. Richard Harte, Philadelphia (2 cases), Dr. Gwathmey, Norfolk, Va. (1 case), and Dr. Vaughan, Washington, D. C. (1 case). In none of the cases gangrene, hemorrhage, or relapse has occurred. The total number of cases of all types of operation would therefore be 149 (to July, 1910).]

These operations have been performed chiefly by American surgeons, many of whom are young men of limited surgical experience, who have begun their apprenticeship in the surgery of the blood-vessel with this operation. These reports have been obtained largely through correspondence and personal solicitation, and have been massed together without selection just as they were reported to me; thus differing from some statistics presented by the compilers of the reports of other methods, who have gathered their material from the literature. Yet with all the disadvantages incident to first attempts, often by inexperienced operators, the total number of necroses or gangrene has not exceeded 5 cases in the 145. Of these five, 4 occurred in the obliterative group in the old series of 85

cases reported in Chicago in 1908 (4.8 per cent.); and 1 in the present series of 60 cases, or 1.9 per cent., also occurring in the obliterative group. I have elsewhere explained (*Journal American Medical Association,* November 14, 1908) that in 3 of the 4 cases of gangrene in the old series, one of the most important precepts of the intrasaccular method (respect for the veins) had been violated, and that the popliteal vein had been injured and ligated in each instance. In the last unpublished series of 60 cases, only one case of gangrene is reported, and this I cannot account for, as the details of the operation in this particular case have never reached me. Summing up the gross results, we find, therefore, a total of 5 cases of peripheral necrosis in 145 operations (3.4 per cent.), all occurring in the lower extremities, in operations of the obliterative type which constitute 72.4 per cent. of the whole number. No gangrenes have occurred after restorative and reconstructive cases, either in the new or in the old series, and no relapses in the cases reported of these two types since 1908.

Believing, as I do, that the intrasaccular method of suture furnishes the best conditions for the protection of the peripheral parts against fatal ischæmia by relieving the tension within the aneurism and the perianeurismal areas, thus giving the collaterals (if they exist at all) the best chance for the establishment of a compensatory circulation, it has, nevertheless, been a matter of great concern to me, before undertaking an operation, to know beforehand to what extent the collateral circulation could be depended upon should an obliterative procedure become an unavoidable necessity. The same thought must impose itself upon the mind of the prudent surgeon every time he is confronted by an aneurism of the carotid or innominate tracts. Here it is not only the safety of the limb that is at stake, but the life of the patient as well. This grave feature of the vascular surgery of the neck has become especially apparent since in the last few years our methods of attacking cervical and facial neoplasms by "bloc dissection" (Crile) have become so much more aggressive and radical in their scope. Hence, we find in the literature of the last three

years, the first evidences of the serious thought that this subject has suggested in the number of preliminary tests recommended before undertaking operations which might involve the suppression of one of the great arterial avenues to the brain. The progress accomplished in this direction is now quite satisfactory, as I will have occasion to show later, but the testing of the collateral circulation in the extremities has been regarded with far less interest than the subject deserves, and it is to this phase of the question that I will direct your attention. Again, in my Chicago address two years ago, in referring to the indications of the reconstructive operation, I said: "The method of determining the peripheral blood-pressure at the very tips of the extremities devised by the Russian surgeon Korotkow, as the result of his extensive experience in the treatment of arteriovenous and other aneurisms in the Russo-Japanese War, and applied successfully by him, Petrov, Fedoroff, Von Oppel, and others, may prove the final solution of the problem" (of determining the efficiency of the collateral circulation in the limbs). "If the peripheral blood-pressure, as shown by the manometer (a modified Gaertner's tonometer), is more or less sustained after the compression of the main trunk immediately above the aneurism, then the main trunk may be safely obliterated in the aneurismal sac. If, on the other hand, the blood-pressure falls to zero, it is evident that the collateral circulation is inadequate and that no chance should be taken with the obliterative operation, or with any procedure whatever (ligation, extirpation, etc.) which would permanently occlude the parent artery."

Since that address was published, the importance of devising some effective and simple means of testing the efficiency of the collateral circulation has been constantly kept before me by a number of cases of popliteal and femoral aneurisms, which have come to me for treatment. The problem has also more frequently repeated itself in the last two years in considering the practicability of extirpating the large root trunks involved in tumors of the thigh and arms. I soon found that Korotkow's method, as I originally understood its technic

through the very meagre details given by Von Oppel in his paper on operative treatment of arteriovenous aneurism (*Arch. f. klin. Chirurg.*, 1908, Band lxxxvi, Heft 1) and by Petrov, of St. Petersburg, at the meeting of the German Surgical Association (*Verhandlung*, Berlin, April 3 to 6, 1907), was of comparative little value in the lower extremities where it was most needed. I found that the rubber rings, which are furnished with the Gaertner tonometer, are satisfactory enough in the fingers, but they are absolutely inapplicable to the toes, especially of adult individuals with deformed feet. I went to the extent of having special inflatable rings made for my Gaertner apparatus by a Philadelphia firm, which I intended to adapt to the toes; but these failed their purpose utterly, as they could not be satisfactorily adjusted; furthermore, in depleted and anæmic individuals with pale, exsanguinated extremities, the color reaction in the small area of the tip of the toes is too uncertain to be relied upon in making any accurate records, and is of still less value in the negro subjects who furnish a large contingent of our hospital clientele. Furthermore, the color reaction which is the basis of this tonometric test can be obtained on a far larger scale in a simpler and more satisfactory way by another vascular reaction, to which I will soon refer. E. Wolf, of Lexer's clinic, in his admirable paper "Die Haufigkeit extremitaten Nekrose nach unterbindung grosses Gefastamme" (*Beitrage zur klin. Chirurg.*, 1908, Band lviii, Heft 3) comes to the same conclusion after experimenting with the method of Korotkow in a case of arterial aneurism of the left femoral artery, complicated with advanced mitral disease. He says: "The measuring of the blood-pressure in the second toe with the Gaertner's tonometer proved difficult and of very little value on account of the pallor of the toes; it is sure not to be at all feasible in many cases." More recently, Kruger, of Riedel's clinic (Jena), in his critical article on aneurism, "Klin. Beitrage zur gefass Chirurg." (*Arch. f. klin. Chirurg.*, 1910, Band xci, Heft 2 and 3), commenting upon Korotkow's suggestion says: "Aside from the fact that this method is applicable to only a

certain number of cases, no absolutely reliable conclusions can be based upon observation made with it. In high femoral and iliofemoral aneurisms it is plainly inapplicable." Further on, he very justly says: "It would be rash, in any event, to arrive at immediate conclusions. The collateral circulation may be very tardy in its development; it is certainly very variable, the cases in which it is established in a few minutes being in the minority. Whatever the precision of the method may be, it cannot be utilized to advantage for practical purposes. *Up to the present day we cannot tell positively in any case of ligature of the large blood-vessels, whether gangrene will or will not occur at the periphery.*" This significant statement, which clearly reflects the status of opinion on this subject in the most advanced centres of surgical culture in Germany, is the more reason why we should endeavor to fill this wide gap in our present knowledge of the physiopathology of the peripheral circulation.

Reverting again to Korotkow's test, it must be said, in justice to this able surgeon, that we know but very little of the details of his technic. I have tried to obtain a full and explicit statement of his method, as described by Von Oppel, but thus far have failed to secure a satisfactory and authoritative description.[1] I am prompted to these remarks by the fact that Korotkow's name is also attached to a method of determining the blood-pressure by auscultation of the peripheral arteries while the main trunk is undergoing compression with a sphygmographic cuff; but this bears no similarity to the method of Korotkow previously described, in which the pressure values of the tonometer are regulated by the appearance of color in the tips of the fingers.[2]

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[1] I have written to St. Petersburg, addressing myself to Von Oppel, who is the best known expounder of his teachings outside of Russia, but I have failed to receive any reply to my queries.

[2] The details of the auscultatory method of Korotkow are given by him in a Russian publication (Wratschnetnajir Gazeta, 1906, No. 5). This method is especially valuable in measuring the minimum so-called diastolic pressure, and has been made the subject of several critical and experimental contributions since it was first brought to the notice of German

This method "which requires practice with great calm and patience" (Fischer) is evidently not intended to meet the requirements of our inquiry. However, whatever may be said of the method, great credit is due to Korotkow for first calling attention to the importance of making accurate observations before operating for aneurism, with a view of determining the efficiency of the collateral circulation after temporary obliteration of the main artery.

Among other means of determining the condition of the circulation after obstruction of the main trunk, I thought of Mosso's plethysmograph, or its various modifications, which could be used to register not only the oscillation of the blood current in the limb, but could give a graphic idea of the relative volume of blood in the extreme periphery of the affected limb, before and after suppressing the main artery. This apparatus was found solely practicable in laboratory experiments, and most difficult to use, if not totally impracticable, in the lower extremity where it was most needed.

The possibility of utilizing very sensitive surface and penetrating thermometers, which would register the differences in the temperature produced by the suppression and readmission of the blood supply of a limb, was also thought of; but it was found difficult to apply sufficiently delicate thermometers outside of the laboratory without serious traumatism to the ischæmic parts.

Putting aside a number of other suggestions intended to

clinicians by Fellner (quoted by Staehlin), "Zur Korotkows'chen Methode der Blutdruckmessung," (Verhdlg. des Kongress f. Innere Medizin, 1909, xxvi). Other excellent and full accounts of this method, as applied by internists, will be found in Lang (Geo.) & Mauswetowa (Sophia), St. Petersburg; "Zur Methodik der Blutdruckmessung nack v. Recklinghausen und Korotkoff" (Deutsches Archiv. f. klin. Med., 1908, Band xciv), and by Fischer, "Die Auskultatorische Blutdruckmessung in Vergleich mit der oszillatorischen v. H. v. Recklinghausen und ihr durch die Phasenbestimung bedrugter klinischer Werth." These references may be profitably consulted by those who are especially interested on the subject. Since this paper was read in May, an excellent review of the whole subject of the auscultatory method, which is accessible to English speaking readers, has been published by Dr. G. C. Gettings, of Philadelphia, in the Archives of Internal Medicine, August 15, 1910, vi, No. 2, 196 *et seq.*

test the existence of the capillary circulation in the extreme periphery of the limbs, which have been suggested but which I have discarded as impracticable at the bedside, I have finally come to consider a modification of the simple proposition made by Moszkowicz, of Vienna, in 1907 (*Mittl. aus d. Grenzgebieten d. med. u. Chirg.*, 1907, Band xvii, Heft 1 and 2), and known as the "hyperæmia test" (which he introduced as a means of testing the limits of the active circulation in gangrenous limbs), as the most practical basis for the much needed test of the collateral circulation. Since 1907, when Moszkowicz's paper was published, I have had several opportunities of testing the value of the "hyperæmic blush" as a means of determining the line of amputation in senile and other presenile forms of arterial gangrene. In each instance, the test has come up to my expectations and, at least in one case, I was able to amputate below the knee, giving the patient the benefit of a better stump than if I had followed the old Heidenhain rule, which made it a routine practice to amputate above the knee, especially in diabetic patients. Since I have been familiar with this simple test, I have thought of its application in a modified form as a means of determining the efficiency of the collateral circulation before undertaking an operation for aneurism. I have also experimented with the hyperæmic reaction in healthy subjects, and this experience, together with the actual observation of its behavior in three recent cases of femoral and popliteal aneurisms, have convinced me that the Moszkowicz test, modified to adapt it to aneurismal conditions, is a valuable asset added to our diagnostic resources. By it, I believe, we obtain a clearer insight into the workings of the peripheral circulation, whenever the obliteration of an important arterial segment is feared or contemplated. The Moszkowicz test for determining the area of the viable or living parts, as distinguished from the dead, or dying, or ischæmic tissues (in cases of senile arteriosclerotic or thrombotic gangrene) is applied as follows: An Esmarch bandage is tightly applied from the tips of the toes or fingers by overlapping in the usual way, as a spiral bandage, to the root of the

extremity. In threatened gangrene of the toes and foot, the band is carried to the groin, where the constrictor or rubber tourniquet is applied. The bandage is allowed to remain from five to ten minutes. The constrictor is then released, and the downward progress of the reactionary pink wave of hyperæmia is observed as it travels to the periphery.

The red blush travels much more slowly as the obstructed territory is approached; it becomes less active and stationary as the total ischæmic areas of the foot or leg are entered. The red color spreads down hesitatingly, almost imperceptibly, especially at the toes. Individual anæmic patches, which are not yet necrotic but which are permanently deprived of blood or circulation, remain white, and the contrast between the red and pale districts becomes more marked with the extent of the arterial obstruction.

It is evident that any operation within the pale or cadaveric zone will end in sloughing of the flap. The proper place to amputate will then be well inside of the red or hyperæmic zone. Moszkowicz made numerous experiments, and found that by injecting colored fluids into the vessels of a cadaver, after ligating the main trunks at various levels, the fluid discolored the skin down to and a little below the level of the obstruction of the main artery. Apart from some variations, he satisfied himself that in the cadaver the limit of cutaneous permeability of the injected fluids was approximately an index to the level of the obstruction in the main trunk of the limb. He concluded from these laboratory experiments that, in practice, the level of the hyperæmic "blush" would approximately correspond to the level of the obstruction in the main artery.

The vast majority of the cases thus far reported, to which this test has been applied, are cases of gangrene of the leg associated with obliteration, partial or complete, of the popliteal artery. There are very few cases, if any, in which the test has been applied for other purposes than to determine the line of amputation in the leg.

Since 1907, Moszkowicz's "hyperæmia test" has been the subject of several contributions which have appeared in the

literature, including the latest articles of W. Bergmann, Lexer's clinic, Konigsberg (Bruns' *Beitrage,* 1909, Band lxiii, Heft 1), that of H. Mendelsohn of Strassburg (Bruns' *Beitrage,* 1909, Band lxii, Heft 2), all tending to confirm the value of the test in establishing the line of amputation in cases of threatened or actual gangrene in the lower limb.

Leaving out of consideration the theories which have been advanced to explain the phenomenon of hyperæmic blush which follows the removal of the Esmarch bandage or any other constricting band at the root of an exsanguinated limb, there are certain facts worthy of remembrance in connection with the clinical application of the test. If the hyperæmia test is tried on the limbs of apparently normal individuals, it will be noticed that when the Esmarch constrictor is removed after it has been kept in place on the upper thigh for five minutes, the color of the limb, which is of a waxy, yellowish white, and cadaveric in appearance during the ischæmic stage, is rapidly transformed to a pink hue by a red blush which spreads, with greater or less rapidity, from the thigh to the toes. The intensity of the red blush varies with many conditions. In negroes and persons with very dark complexions, the blush is hardly appreciable, except at the soles of the feet, the nails, and the balls of the toes, which are not pigmented, and in the same regions of the hands. The reactionary wave is most striking in individuals of the fair, blond type. However, the blush is distinctly marked and unmistakable, even in the blackest negro, in the palms, soles and other parts previously mentioned. This is fortunate, because it is precisely in these terminal territories of the extremities that the life of the tissues is most frequently in doubt. The rapidity with which the blush spreads from base to periphery is not constant in all cases; in the minority, the knee is reached in from one to two seconds; the average time is five; the longest, fifteen seconds. The ankles become red quickest—after two to three seconds, average ten; latest appearance, twenty-five seconds; average fifteen seconds and, in the slowest cases, thirty seconds. Age has no essential bearing on the rapidity of the wave; according to Bergemann

the reactionary hyperæmia spreads more rapidly in the aged than in the young. "In a man, aged seventy-six years, the toes became pink in five seconds; in a child of four years, not until thirty seconds later." When the constricting bandage is kept in place a longer time, ten minutes for instance, the appearance of the redness is almost invariably delayed, but it becomes more marked when it does come. It is noteworthy that occasionally in some individuals, small, scattered, irregular patches remain like islands of white skin surrounded everywhere by the red blush. These patches, as first observed by Bergemann, are more often observed in the lower segment of the leg and on the dorsum of the foot. Once the hyperæmic wave has spread over the limb, it becomes intensified for a variable period of a quarter of a minute to one or even two minutes, then the redness becomes stationary for a few seconds and gradually pales to the normal living color in the course of five to ten minutes, or even longer. The retardation of the hyperæmic wave in proportion to the duration of the wave is accounted for (W. Bergemann) by an automatic reflex contraction of the vessels (possibly including in this the endothelial cells of the capillaries), which, at first, offer a resistance in the ischæmic zone which is greater in direct proportion to the duration of the ischæmia.

According to this view, the arteries and even the capillaries open their lumina wider in proportion to the blood famine. The returning blood relaxes the vascular spasm, but this spasm must be overcome before the returning capillary wave can advance further. This interesting hyperæmic reflex is more manifest in the young, because the automatic vasomotor mechanism is at the height of its physiological activity and the muscularis and other tunics of the artery are most efficient because they are free from degenerating lesions and influences. In the aged, the hyperæmic reflex of blood appears more promptly, owing to the impaired contractility and elasticity of the arteries; the spastic stage is not as lasting or as constant as in youthful individuals. It has been claimed that the failure of a reactionary hyperæmia to appear is indicative of the occlu-

sion of the main artery of the part, and in the cadaveric experiments of Moszkowicz, the colored fluids were usually arrested in the skin some distance below the immediate level of the ligature of the vessel.

The test, in the form originally suggested by Moszkowicz, has been utilized as a guide to the line of amputation in dry senile or presenile gangrene of the lower extremity—a very different matter from the application of the test in cases of aneurism. As the result of my clinical and experimental observation on normal individuals, the appearance of a hyperæmic wave after constriction of a limb is indicative of a free supply of blood in the hyperæmic area. *In healthy, normal limbs, the occlusion of the main artery of a limb does not, necessarily, suppress the hyperæmic wave in the distal parts below the obstruction, as long as the collaterals are pervious and sufficient to carry the blood beyond the level of the obstruction in the main artery.* The distinctness of the blush varies considerably according to the condition of the collateral circulation after constriction. The intensity of the blush would seem to be directly proportional to the activity of the collateral circulation. It is also true that as long as there is a reactionary blush or a restoration of the *living* color, no matter how faint it may be or wherever it may be, *there,* it may be said, the tissues are alive; while the indefinite persistence of a cadaveric pallor is ominous of a suppressed or impeded circulation.

It cannot be said, with Moszkowicz and others, that the presence of the hyperæmic wave means, necessarily, that the main arteries are pervious, or that if the blush does not appear the main artery is occluded. It is not so much as a test of occlusion of the main arterial trunk of a limb that I would advocate the Moszkowicz test, but as a means of demonstrating the existence of a capillary circulation beyond the level of the arterial occlusion—a pink color, no matter how faint, meaning life; a colorless cadaveric pallor meaning death.

Does the failure of the hyperæmic blush necessarily indicate that there is no circulation in the parts beyond the arterial obstruction? Not always; there may be no distinct wave, no

appreciable blush; but as long as there is some pink or "living" color—I mean color that can be made paler by pressure—there is some circulation; an absolute waxy pallor means complete ischæmia and ultimate death of the colorless parts if it persists.

In cases of senile or other forms of dry gangrene, we do not apply the Moszkowicz test to determine the level of the arterial obstruction, as he does, but solely to obtain a definite idea of the level of an active capillary circulation. My own clinical observations have convinced me that as long as there is a free or efficient collateral circulation, the hyperæmic wave, in an intense or modified form, will appear after the removal of the constrictor and will spread over the limb to every part of the periphery; it may not be as bright and brilliant as in a normal limb, but a living and gradually increasing living flesh color will appear, in spite of the occlusion of the main artery. The following observation will clearly prove my contention:

A young man, aged twenty-three years, was shot accidentally with a revolver in the right thigh, the bullet penetrating the middle third of the limb on the inner side. Shortly after the accident, a large pulsating hæmatoma developed, which his attending physician, Dr. Cunningham, recognized as an acute traumatic aneurism of the femoral. This occurred on December 26, 1909, at Sibley, Alabama, and on January 20, 1910, he was brought to me for treatment. There was a well-developed aneurism, involving the femoral just before its entrance into Hunter's canal. There was no evidence of associate venous injury. The tumor was growing rapidly. The operation was performed on January 21, about one month after the injury. The circulation was controlled by the Esmarch bandage and constrictor. The sac was opened freely, a large mass of rapidly organizing clot with a beginning endothelial lining was removed, exposing the injured femoral. The artery had been completely divided by the bullet, the ends retracting with the sheath for a distance of nearly one and a half inches. It was plainly an arterial injury without any sac formation. The divided ends of the artery were so far apart that no attempt at a circular or "end-to-end" arteriorrhaphy could be considered. I merely clamped the terminal ends

of the artery with soft rubber-covered (Hoepfner) forceps and, after securing all recognizable bleeding points in the wound, ordered the constrictor to be removed. We then watched for the hyperæmic wave. The constrictor had been on for about eighteen minutes, and the wave was delayed fully eighteen seconds before it appeared; then it came with a rush, right down to the knee; then it stopped, hesitated for a few seconds, and spread gradually, slowly but steadily, in the course of six minutes, to the very tips of the toes. The appearance of the leg and foot, which for fully five minutes had remained cadaverically pale, gave us great anxiety until we saw the pink blush gradually spread all over the foot and over each toe. The coloration of the toes and foot was not as intense as in the thigh, but it was quite sufficient to satisfy every one present that the peripheral circulation had been restored, and that the collaterals were efficient, though the dorsalis pedis and posterior tibial had ceased to pulsate. Had the reaction failed to appear and the cadaveric pallor remained, what then? I had fully decided that, in the event the collaterals failed, I would try to restore the continuity of the divided femoral by grafting a venous segment from the opposite saphenous. Realizing the uncertainty of this procedure, I was delighted that, with the help of the Moszkowicz test, we were able to obtain a most convincing demonstration of the efficiency of the collateral circulation, in spite of the occlusion of the femoral. I therefore ligated the ends of the divided vessel and closed the wound. The patient made an uneventful recovery, and the circulation in the foot never gave us a moment's anxiety, though the pulses at the ankle never returned.

After satisfying myself, by tests on normal individuals, that the occlusion of the main artery of a limb is no bar to the appearance of living color reaction, if not a hyperæmic wave, in the distal parts as long as the collaterals are intact, I devised the following test, which I have tried on a number of healthy individuals. The test was found very effective in two recent cases of pathological popliteal aneurism in markedly arterio-sclerotic subjects, in whom it was especially important to know the condition of the collateral circulation as a preliminary to undertaking an endo-aneurismorrhaphy.

For the purpose of testing the collateral circulation in cases of aneurism, I have found that the tourniquet introduced about thirty years ago in the Massachusetts General Hospital for the purpose of applying immediate direct compression on the arteries as a substitute for digital compression in the treatment of aneurism, and known as the " Massachusetts Hospital Compressor" (manufactured by Codman and Shurtleff), is especially useful for this purpose. Better than any other compressor that I am acquainted with, the rubber pad over the wooden block, used as the compressing agent, can be adjusted to the artery more accurately and kept in place more steadily and with less interference with the circulation in the parts outside of the compressed area, which is not much larger than the surface covered by a silver dollar.

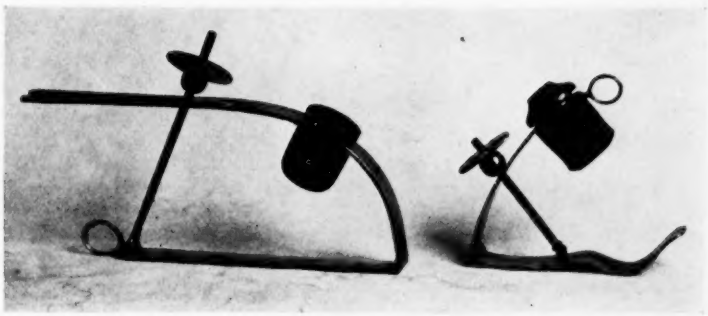
On the other hand, it has the disadvantage common to all compressors applied to the roots of limbs, that it obliterates the vessels in a very considerable and variable mass of tissue on a level with the flat compressing steel band, especially at the point where counterpressure is necessary to steady the appliance. It leaves a lateral area sufficiently free from pressure on each side of the axis of compression to allow the bulk of the collaterals to remain unobstructed (see Fig. 1).

Realizing the necessity of reducing the points of pressure and counterpressure to the strictest minimum compatible with a firm grip of the limb and a graded compression of the main artery, I have planned a different appliance based on the principle of a calliper, which is now under consideration by an instrument maker.

In testing an aneurism of the popliteal, which we may select as the most frequent example of the surgical type of this disease, the first step to be taken in applying the test is to put the patient on his back and expose the affected limb on a white cloth or sheet, which will show the contrast of the color of the skin to the best advantage. A good daylight is, of course, necessary.

Begin by determining the line of the femoral in Hunter's canal, and adjust the block of the compressor over this line

FIG. 1.

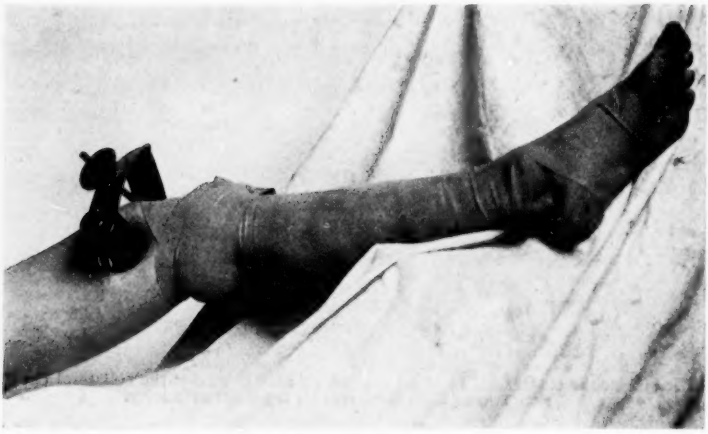


The Massachusetts General Hospital compressor used in testing the collateral circulation, two models: the larger for the lower extremity.

FIG. 2.

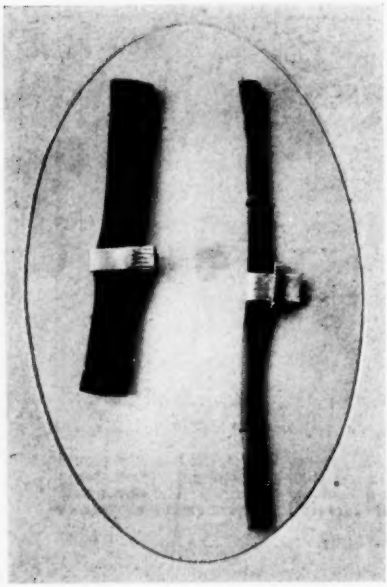
The compressor applied to the upper brachial artery. The elastic bandage should be applied more completely over the padded fingers than is shown in the photograph. The band should not extend beyond the upper pole of the aneurism. The upper pole should be exposed to permit the finger of the observer to determine the absence or presence of pulsation.

FIG. 3.



The compressor applied to the femoral at Hunter's canal. The same defective application of the elastic bandage occurs in this illustration as in the preceding photograph; the toes should have been completely covered by the elastic bandage.

FIG. 4.



Types of removable aluminum bands used to occlude the arteries.

FIG. 5.

The aluminum band used as an aneurism needle it is readily adjusted in this shape to the contour of the artery.

at a point nearest the aneurism without encroaching upon the sac. Then tighten the compressor on the artery until all pulsations and sounds cease in the aneurism and the volume of the swelling is reduced. At this juncture, if there is a peripheral pulse in the dorsalis pedis and posterior tibial, the pressure should be continued until these peripheral pulses cease absolutely.

After keeping the tourniquet on for some time while the aneurism is *absolutely still* and collapsed, some change may be noticed in the color, the temperature, and the sensibility of the skin below the knee and especially of the foot and leg. As the pressure is continued, the limb will become colder and paler at the digits, and the patient will complain of numbness and a dead feeling in the foot and leg. Observations on the color and temperature of the foot while the aneurism is " still " are in order. It is probable that as long as the collateral circulation is efficient, the change in the color of the limb, while becoming markedly paler at first and for some time after the compression is continued, will remain at a standstill or improve according to the efficiency of the collateral circulation. The variations in color noticed after simple compression of the main trunk above the aneurism are not always marked enough to allow the observer to arrive at definite conclusions, especially as the bulk of the blood originally in the limb before the experiment began has not been displaced by forcible exsanguination with elastic pressure.

After familiarizing himself with the position of the artery at the point *nearest* the aneurism, where it can be compressed with accuracy, the assistant is prepared to temporarily relax the pressure and proceed to the application of a broad Esmarch elastic bandage, which is to be adjusted snugly from the tips of the toes, compressing these more evenly over several layers of gauze, and continuing the roller until the upper level or pole of the aneurismal swelling is reached. At this level, the bandage is firmly held in position with a clamp and fixed while the operator readjusts the compressor until all pulsation in the sac is absolutely arrested and the aneurism is *stilled*. The

same tactics will apply equally well in arteriovenous aneurisms, though I have had no experience with this test in such cases.

With the finger of the operator constantly on the aneurism to make sure that its pulsation is absolutely controlled, the elastic bandage is held in place for five minutes in old subjects or eight in the younger patients, especially in dealing with traumatic cases (in these less risk of thrombosis, embolism, and injury to the artery). The elastic bandage is now quickly removed, while the compressor still secures the main artery.

Close attention must then be given to the returning hyperæmic wave, and the progress of the blush is noted as it descends rapidly at first in the zone immediately below the level of compression.

In order to test the collateral circulation in normal subjects by the method already described, the writer undertook this summer (1910) a series of observations on several members of the Touro Infirmary Staff, who kindly consented to the tests, which are detailed in the 11 observations which follow. Seven of the subjects were young physicians, members of the hospital corps, all vigorous and healthy; four were nurses in the training school, all normal, active young women. The circulation in the lower extremity was tested in the young men; the upper extremity, in the women. The ages of the men varied from twenty-two to thirty-one years; in the women from nineteen to thirty-three years. The blood-pressure was taken in the majority of the individuals experimented upon. This was done with a Cook's modification of the Riva-Rocci and an Olivier watch dial manometer.

The procedure adopted in testing the upper extremity was:

1. To elevate the arm, so as to drain all excess of venous blood and until the hand and forearm became pale from gravity anæmia.

2. The brachial was compressed with the Massachusetts Hospital compressor in the upper third of the brachial artery immediately below the insertion of the pectoralis major tendon, the compression continued until all the peripheral pulses (brachial at bend of elbow, radial and ulnar at wrist) were totally obliterated.

3. The effect of this procedure on the color of the extremity, and especially in the hand and finger-tips, was carefully observed by myself and two other medical members of the staff. All the variations in the color of the skin, and after of the sensibility and surface temperature were noted, varying from the waxy cadaveric pallor of complete ischæmia to a normal living flesh color or a hyperæmic pink. These observations were duly noted on the spot by a recorder, as they appeared successively in the arms, forearms, wrist, hand, palms, digits, and nails.

The same experiment was repeated in the majority of cases, with the addition of the complete ischæmia obtained by applying the elastic (Esmarch) bandage from the tips of the digits to the level of the compressor, which remained *in situ* after it had been demonstrated that the peripheral arteries were pulseless (Fig. 2). The elastic bandage was held in place from three to eight minutes, sometimes ten. On removal, the efficiency of the compressor in obliterating the brachial artery was demonstrated by the suppression of all the peripheral pulses and the persistence of cadaveric pallor. If there was the slightest evidence of a return of pulsation to the wrist or elsewhere, the experiment was repeated, the compressor readjusted, and the elastic bandage reapplied.

In the lower extremity, the femoral trunk was compressed with the block of the compressor resting on the artery at the apex of Scarpa's triangle, or a little higher in thin subjects (Fig. 3). The pulsations of the dorsalis pedis and posterior tibial behind the malleoli were completely noted before applying the elastic bandage. Then the color changes in the limb from the thigh to the toes were carefully noted after the removal of the elastic bandage while the compressor was *in situ*.

The brachial was always easily controlled; the femoral offered greater resistance to compression, especially in muscular subjects. However, the total suppression of the ankle pulses, together with the waxy, unmistakable cadaveric hue, always demonstrated the total ischæmia.

In presenting the individual observations, we have merely summarized the copious notes taken by the recorder and retained only the essential and most important notes.

OBSERVATION 1.—Dr. A. S. C., male, aged twenty-five years; normal pulse full and strong. Blood-pressure, 120. Compressor applied to brachial upper third; color remains in periphery including digits in spite of total obliteration of pulse at elbow and wrist.

Esmarch applied with brachial compressor *in situ*	22′ 15″
Esmarch removed with brachial compressor *in situ*	23′ 15″
Cadaveric pallor; no hyperæmic wave	23′ 15″
Flesh color returns almost to wrist	26′
Better color in cadaveric palms	28′
Patches of red begin to appear in hand	30′
Pulps of fingers and palms are getting pink	33′
Brachial compressor removed	34′
The pink color is intensified and diffused like a distinct hyperæmic reaction	34′ 15″

NOTE.—In this case, a living pink color was restored to the upper limb while compressor was *in situ*, in 11′ 30″.

Lower Limb.—Compressor applied to the femoral at the apex of Scarpa's triangle. Dorsalis pedis and posterior tibial pulses completely suppressed. Living color in limb unchanged.

While compressor *in situ*, Esmarch applied to middle thigh	42′
Esmarch removed, cadaveric color	43′
Red wave down to knee	43′ 15″
Leg assumes living color to within 4 inches above malleoli	43′ 30″
Foot still cadaveric	43′ 30″
Foot and toes show living color (without hyperæmia)	43′ 40″
Compressor removed, distinct hyperæmic wave over whole limb	43′ 50″

NOTE.—Living color assumed in lower limb in spite of obliteration of femoral in 1′ 40″.

OBSERVATION 2.—Dr. M. J. deM., male, aged twenty-three years. Blood-pressure, 115.

Lower Limb.—Notable pallor on compression of femoral at Scarpa's triangle, sufficient to obliterate ankle pulses 55′

Esmarch applied with compressor *in situ*	56′ 15″
Esmarch removed with compressor *in situ*	59′ 15″
Red wave to knee with compressor *in situ*	60′

Red color to mid-leg with compressor *in situ*..... 61′
Decided hyperæmia to tubercle of tibia..... 61′ 30″
Still pale, but living color to ankle..... 62′
Living flesh color to malleoli..... 67′
Color begins to show in toes..... 69′ 30″
Compressor removed ..... 70′
Marked hyperæmic wave diffused over limb to toes... 70′ 20″

NOTE.—In this case a living flesh color was restored to limb while femoral obliterated, in 10′ 20″.

OBSERVATION 3.—Dr. J. M. M., aged twenty-two years; good full pulse at ankle (blood-pressure not stated). Compressor applied to femoral at Scarpa's triangle; ankle pulses obliterated.

Esmarch applied at once and removed, leaving limb in cadaveric pallor ..... 10′
Pink color appears to tubercle only of tibia..... 12′
Tips of toes pinkish..... 13′
Color returns to toes..... 15′
Compressor removed ..... 15′ 15″
Hyperæmic blush over whole limb..... 15′ 30″

NOTE.—In this case a living flesh color returned while compressor was *in situ* in 5′ 15″.

OBSERVATION 4.—Dr. J. G. H., aged twenty-six years; full regular pulse (no blood-pressure record).

Upper Extremity.—Living flesh color retained after compressor applied to brachial upper third; the pulse at elbow and wrist obliterated ..... 41′
Esmarch applied ..... 41′ 30″
Esmarch removed (cadaveric pallor)..... 44′
Hand still cadaveric..... 44′ 30″
Little pink to elbow..... 44′ 45″
Living color in forearm..... 45′ 25″
Living flesh to wrist..... 46′
Some pink in hypothenar region..... 47′
Decided flesh color in palm and hypothenar region... 48′
Little pink in nails..... 49′ 15″
Nails decidedly pink ..... 50′
Living color over entire limb..... 50′ 45″
Compressor removed; marked hyperæmic wave..... 51′

NOTE.—A normal living color restored to entire limb with compressor *in situ* in 9′ 45″.

OBSERVATION 5.—B. W. W., aged twenty-five years. Full pulse; blood-pressure, 120.

Lower Limb.—Compressor applied to femoral at Scarpa's triangle; slight pallor, though living color retained in spite of obliterated pulses. Very distinct hyperæmic blush over entire limb follows removal of compressor.

Compressor reapplied, pulses obliterated, and Esmarch applied to mid-thigh	38′
Esmarch removed	42′
Light pink color to internal condyle	42′ 20″
Light pink color to heel	44′
Toes begin to show living color	44′ 20″
Living color over limb	46′

NOTE.—Living color restored in this case throughout limb in 4′, while compressor *in situ* and arteries pulseless.

OBSERVATION 6.—Dr. J. W. S., aged twenty-three years; full pulse; blood-pressure, 112.

Lower Limb.—Compressor over femoral at Scarpa's triangle.

Esmarch's elastic bandage applied	27′
Esmarch removed, cadaveric pallor	30′
Living color to knee	31′
Living color to tubercle of tibia	31′ 15″
Living color at heel, dorsum of foot, and in big toe	38′ 30″
Living color in tips of toes	45′
Living color in whole limb, except big toe	46′
Compressor removed, followed by marked hyperæmic wave	46′ 20″
Hyperæmic blush intensified	46′ 55″

NOTE.—The living color was restored while compressor was ***in situ,*** in 19′.

OBSERVATION 7.—Dr. H. T. M., aged twenty-four years. Athletic. Blood-pressure, 122.

Lower Limb.—Compressor and Esmarch applied at Scarpa's triangle.

Limb pale and pulseless	12′
Living color to ankle	15′
Living color on dorsum pedis	16′ 30″
Living color in toes	17′
Distinct hyperæmic blush while ankle pulses still obliterated	20′
Compressor removed, but no reactionary blush follows, as limb is already hyperæmic.	

NOTE.—In this case, not only the normal living color was obtained, but a distinct hyperæmic blush followed in 8′.

The experiment was repeated with practically the same results. It is

evident that the rapid restoration of the circulation with the hyperæmic blush, while the ankle pulses were obliterated, can only be accounted for by the existence of an unusually large collateral.

OBSERVATION 8.—Miss W., aged twenty years. Normal blood-pressure, 110.

Compressor applied to upper brachial, sufficient to obliterate all peripheral pulses	15′
Forearm shows living color to wrist; hand cadaveric	17′ 2″
Little color appears in hypothenar region	18′ 30″
Very slight signs of flesh color in hand	21′
Living red in palm and pulps of fingers, with disseminated cadaveric patches	31′
Compressor removed, hyperæmic flush returning	31′ 10″
Hyperæmia intensified	31′ 50″

NOTE.—Fully 18′ 22″ elapsed in this case before living color returned to extremity.

OBSERVATION 9.—Mrs. B., aged twenty-seven years. Blood-pressure, 115.

Compressor applied after gravity anæmia; pulses obliterated	29′
Arm and forearm show living tint	31′
Little color appears in pulps of fingers	36′ 30″
Tips of fingers and nails show pink color	37′ 30″
Living color spreads over fingers	39′
Compressor removed; hyperæmic flush returning	39′ 7″
Hyperæmia intensified	39′ 47″

NOTE.—Fully 10′ elapsed before living color was restored after application of compressor.

OBSERVATION 10.—Miss B., aged thirty-two years. Blood-pressure, 100.

Compressor applied after gravity anæmia; pulses obliterated	39′
Distinct living color to wrist	41′
Esmarch bandage applied while compressor still *in situ*	44′ 30″
Esmarch removed	47′ 30″
Extremity cadaveric	48′ 30″
Living color spreading to elbow and back of forearm	49′ 30″
Forearm shows living color	52′
Living color in pulps of fingers	57′
Compressor removed; hyperæmic blush returning	57′ 5″
Hyperæmia intensified	58′ 5″

NOTE.—Living color restored in 10′ after compressor applied.

OBSERVATION 11.—Miss S., aged nineteen years. Blood-pressure, 110. Gravity anæmia followed by compressor applied to upper brachial.

Pulse obliterated	10′
Living pink color spreads to elbow	10′ 30″
Living pink color spreads to mid-forearm	12′ 30″
Living pink at tips of fingers	12′ 45″
Living color in palm	13′
Cadaveric color passing from hand	17′
Living color returning uniformly over hand	18′ 30″
Compressor removed; hyperæmic blush returning	18′ 50″
Flush intensified	18′ 50″

NOTE.—Living color restored in 9′ 25″, while compressor *in situ*.

SYNOPSIS.

Six observations on the *upper extremity* (brachial compressed); 4 women and 2 men; circulation restored during compression of brachial in minimum time of nine minutes, twenty-five seconds; maximum time, eighteen minutes, twenty-two seconds; average time, eleven minutes, thirty-seven seconds.

Six observations on *lower extremity* (all men). Femoral compressed at Scarpa's triangle. Circulation restored in minimum time of one minute, forty seconds; maximum time, nineteen minutes; average, eight minutes.

In summing up the results obtained from these experiments, it is at once apparent that while these observations are most encouraging and suggestive, they are still very incomplete from the point of view of numbers and the lack of observations on mature and aged subjects. It is also apparent that color reaction obtained in the majority of cases is not, strictly speaking, a hyperæmic reaction in a literal sense, and that it would be an error to expect in every case or even in the majority anything like the intense and rapidly diffused blush which is obtained after applying an elastic tourniquet, or after releasing the grip of the compressor or tourniquet on the main artery.

This wave of intense hyperæmia in its red, wave-like phase, is usually limited to the regions close to, or a short distance below, the level of the compressor. The intense hyperæmic blush gradually fades away into a pale pink or a simple flesh

tint without sharply defined margins, but quite sufficient to be distinguished by the careful observer as a living capillary tint in contrast with the dead, waxy, cadaveric hue of complete ischæmia. In view of the fact that peripheral arteries, at the ankle or wrist, remain pulseless while the parent trunk is compressed, it is not likely even if one of these vessels, such as the dorsalis pedis, were cut into, that blood would flow in a stream; all that could be expected would be a sluggish capillary ooze which would no doubt increase as the experiment was prolonged and the collateral circulation asserted itself. The capillary bleeding would be quite sufficient to confirm the existence of a circulation in the areas below the level of the compression. In some of the cases in which a positive pink color and even an intense hyperæmic blush is noticed in the distal parts, it is more than likely that a free hemorrhage would follow a cut into one of the tissues. However, the important point that is fairly proved is that in spite of absolute pulselessness, a normal, living flesh, pinkish color is all that is necessary to indicate that the limb is alive and not likely to perish from ischæmia. These experiments also show that the elastic constrictor is not essential to obtain the hyperæmic or other color reactions. The only reason why it is preferred to gravity anæmia is that it is more effective in obtaining that absolute ischæmia which is followed by the typical, waxy, cadaveric hue of perfect bloodlessness, and that, in this way, the eye of the observer is better able to follow the color changes that occur after its removal. It is also more valuable than gravity anæmia for the same reason, viz., that the vascular reaction is more intense and visible in proportion to the completeness of the preceding ischæmia.

In aneurisms, especially popliteal aneurisms, in which the ankle pulses have been obliterated spontaneously by probable embolic or thrombotic obstruction of the tibials (a not infrequent occurrence in practice), gangrene of the foot ensues if the collaterals are not sufficiently developed. The survival of the limb after such an accident and the preservation of a normal color and sensation in the peripheral parts, in spite of the loss of the ankle pulses, clearly prove that a compensatory

circulation has been established and that no fear of gangrene after obliteration of the main artery or of the aneurism itself need be entertained. This relative immunity from gangrene of patients suffering from aneurism, who have lost their peripheral pulses (ankle pulses) without gangrene or impairment of the nutrition of the foot, has been long noticed by French observers, and is clearly founded on sound reasoning. (See *Bull. et Memoires de la Société de Chirg. de Paris,* 1909.)

In addition to the preceding considerations, the question of how long the compressor can be kept *in situ* waiting for the color reaction to appear arises.

Does the persistence of the cadaveric hue for one hour or more necessarily prove that the limb will not survive the occlusion of the main artery, if this is attempted?

Judging by mere clinical experience, the answer is certainly no. But if a limb remains cadaveric, cold, and numb, and never changes color for an hour in spite of hot air baths, massage, etc., it should make us very cautious how we undertake the obliteration of the parent artery. Furthermore, it is a question how long patients can endure the pressure of a mechanical tourniquet steadily applied to the main artery for diagnostic purposes. Many of the young men and women tolerated the pressure for eighteen and twenty minutes with comparative ease, but it is doubtful if every one could stand it longer than an hour without much suffering. In some instances in which it is very important to know the state of the circulation, the sitting might be prolonged by occasional inhalations of ether. However, a sitting of one hour under the compressor without changing the cadaveric hue would suffice to put the operator on his guard, and justify his postponement of the operation.

The following experience with a case of popliteal aneurism will serve to illustrate the mode of testing the collateral circulation, and also show how satisfactory it is in practice:

C. P., German, laborer, aged forty-two years; was admitted June 26, 1910, at the Touro Infirmary, for the treatment of a

large, well-developed aneurism, which filled the right popliteal space. There was a history of syphilis, gonorrhœa, and rheumatism, but no alcoholism. The aneurism developed nine months before admission, while the patient was working in a lumber camp, when he slipped while straining every muscle to prevent a load of lumber from sliding off a wagon. He particularly strained his right knee, but it was not until January 22, 1910, nearly two months subsequent to the injury, when he awoke to find his right leg stiff and swollen from the knee to the ankle. Since then a characteristic pulsating tumor, presenting all the classical signs and symptoms of aneurism, has gradually developed, and led to a complete disability on account of swelling and pain in the limb, when he attempted to stand or work for any considerable length of time. The aneurismal limb was œdematous and larger by one inch in circumference on a level with the patella, calf, and supramalleolar regions.

With the inflatable Cook's cuff as a constricting band, applied at the mid-thigh, the aneurism was not *stilled* until the dial of an Olivier manometer registered 150 mm. mercury.

On admission, the collateral circulation was tested as follows:

An Esmarch elastic bandage was applied from the toes to the upper pole of the aneurism in the popliteal space, allowing enough of the pulsating tumor to remain exposed for digital exploration, in order to control the efficiency of the compressor in arresting the circulation in the aneurism. The observations recorded by Drs. Gamble and Moore, internes of the service, are as follows:

Esmarch applied to upper level of aneurism	11.29.00 A.M.
Compressor applied to femoral at Hunter's canal; the aneurism collapsed and *still*	11.35.00 A.M.
Esmarch removed	11.40.00 A.M.
Distinct living flesh color appeared as far as knee	11.40.05 A.M.
Color as far as tibial tuberosity	11.41.00 A.M.
As far as lower calf and malleoli	11.41.20 A.M.
Distinct living color in foot with decided hyperæmia in calf	11.41.30 A.M.
Toes pink	11.42.00 A.M.
Foot shows a pink color	11.42.30 A.M.
Foot is hyperæmic	11.43.00 A.M.

The compressor was removed at 11.43 A.M.

The hyperæmic blush became diffused over limb and was intensified immediately after compressor was removed.

In this case it took just three minutes to restore a living color to the entire limb with marked hyperæmia of the foot, while the compressor was *in situ*, the aneurismal pulsation and the dorsalis pedis and posterior tibial pulses being completely obliterated in the meantime.

The experiment was repeated several times as a demonstration before students and visitors, and always practically with the same result. The only conclusion was that in this case the collaterals were very well developed and that the obliteration of the aneurism could be effected without fear of dangerous ischæmia to the limb.

NOTE.—On account of a severe burn, caused by accidentally rubbing the affected leg, including the aneurismal site, with carbolic acid instead of alcohol, the operation on the aneurism was delayed until August 22, 1910. This misfortune, however, did not prevent the final confirmation of the excellence of the collateral circulation indicated by the preliminary tests, as is shown by the following notes taken at the time of the operation.

C. P., ether (drop) narcosis. Operation begun at 11.40. Completed at 1.15 P.M. (including all dressings). Esmarch constrictor applied at mid-thigh. Sac opened and large amount of organized clot removed. Fusiform sac with two openings at each pole on same horizontal level. Space between inlet and outlet nearly three inches. After toilet of sac, a typical obliterative endo-aneurismorrhaphy was performed. Sac buried without drainage. Contents removed and a hyperæmic wave was noticed as far as knee in fifteen seconds.

A distinct flush as far as middle of calf in..... 1′
Living flesh color, but no hyperæmic wave at foot or sole of foot in..... 1′ 40″
Living color in the foot in..... 2′
Nor. pink color in sole of foot and tips of toes in..... 3′

Therefore in *three* minutes after the constrictor had been removed, it was plain to everyone that, while the hyperæmic blush had been limited to a zone extending just below the level of the obliterated popliteal, a distinct living, and unmistakable pink color had spread gradually all over the limb to the toes. The transformation from a cadaveric pallor to the living pinkish color was easily followed in this patient, as he was of a very fair, blond,

German type. The dorsalis pedis and posterior tibial pulses were permanently suppressed by the operation.

The normal warmth and sensibility of the foot and toes returned in a few minutes after operation, and the patient made an uneventful recovery, save for a superficial suture suppuration, which occurred in the site of the carbolic acid burn.

Another and earlier experience (March, 1910) with the preliminary test of the collateral circulation as applied to a pathologic popliteal aneurism presents features which are most instructive and worthy of special consideration.

The patient, A. B., a lawyer, aged forty-five years (of Greenville, Miss.), was referred to me through the courtesy of his attending physician, Dr. P. E. Odeneal.

He showed marked evidence of general presenile arteriosclerosis, with a loud but well-compensated mitral lesion. He had noticed the aneurism fully eighteen months before he came to me for treatment.

The aneurism was ovoidal in form and filled the left popliteal space. It involved the entire space, but bulged upwards, encroaching upon the lower femoral tract. In view of the marked thickening of the peripheral arteries and unmistakable stigmata of arterial degeneration and high blood-pressure, I was especially anxious to test the collateral circulation. The hyperæmia test, as above described, was applied. The compressor was adjusted to the femoral at the lowest level of Hunter's canal, until the aneurism was stilled completely. The elastic bandage was applied and allowed to remain eight minutes. It was most interesting to watch the wave of hyperæmia as it rapidly descended at first to the middle of the leg, then hesitated, but slowly and steadily spread to the toes. The reddening of the entire limb was complete within two minutes.

With this evidence before me of what I considered a fair proof of the amplitude and sufficiency of the collateral circulation, I decided to attack the aneurism the next day, feeling confident that, if the conditions in the sac were not favorable for either a restorative or reconstructive endo-aneurismorrhaphy, the obliterative type of operation could be adopted without risk to the limb. Instructions were, therefore, given to prepare for the operation the next morning. When the hour came to operate, on March 1,

I again examined the limb, and much to my surprise, I found the foot and leg pale and colorless, and much colder than the foot on the opposite side. The patient had passed a restless night, and complained several times of sensations of numbness in the affected leg. His blood-pressure was higher than on the previous day by at least 20 mm. with the Riva-Rocci sphygmomanometer. This was attributed to worry and apprehension, but what was unsuspected and most significant was the total disappearance of the pulse in both arteries of the foot. The dorsalis pedis and the posterior tibial were readily identified as thick cords, but pulseless. What had happened during the night, is the question? The only rational explanation that I could conjecture was, that an embolus had been detached from the sac after the removal of the compressor the previous day, and that this had blocked the popliteal at its bifurcation. The aneurism itself pulsated as vigorously as ever. In the presence of this complication, all idea of operating upon the aneurism was abandoned, and the patient was brought back to bed and warmed up; the limb itself was placed in a hot air chamber, with the view of inducing as much active hyperæmia as possible. This was kept up for one hour, to be followed by an active massage over the whole leg, beginning at the tubercle of the tibia. After this, hot water bags were kept around the limb, which was wrapped in thick, large rolls of cotton batting.

Two hours after these measures had been taken the limb was found much less pale, sweating in the leg had occurred during the hot air treatment, and the nails were less pale and dusky. A very faint but appreciable pulsation could be detected in the posterior tibial. In six hours the color of the limb and the sensibility were almost normal, and the posterior tibial could now be felt beating vigorously behind the posterior malleolus, though no pulse returned in the dorsalis pedis. Presumably, the embolus had been partially dislodged from the bifurcation, leaving the lumen of the posterior tibial free, while the anterior was still blocked. At any rate, a collateral circulation had been sufficiently established to protect the foot. This would have been a good opportunity to try the hyperæmia reaction, but the fear of dislodging some more clot and again occluding the tibials made me desist. I then decided, in view of the return of circulation, to try the hazard of an operation. Accordingly, that same evening, the patient was etherized, and with the circulation controlled with

the Esmarch constrictor at the mid-thigh, a free incision was made into the sac, with extra precautions to avoid injury to any of the perianeurismal veins or nerves. The sac was opened freely, and a large mass of soft and partially laminated clot, amounting to about two cupfuls, was removed. The sac wall was tough and dense, and the two main orifices were clearly identified in the neighborhood of each pole, separated by a distance of nearly two and a half inches. There was no distinct groove at the bottom of the sac, and no folds to indicate a trace or vestige of the parent artery. Evidently the aneurismal dilatation involved the circumference of the artery, forming a typical fusiform sac, except for the flattened floor caused by the resistance of the posterior surface of the joint. After completing the toilet of the sac by gently scrubbing it with a salt water gauze pack, the orifices, which were quite large, were gently explored with a soft rubber catheter lubricated with sterile vaseline. The catheter readily passed into the lumen of the distal trunk for a short distance before engaging into a narrower channel, which I took to be the posterior tibial. A long, narrow, blunt-pointed forceps, well lubricated with sterile vaseline, was also introduced into the lumen of the distal trunk to the bifurcation, with the hope that some clot might be extracted, but owing to the need of great caution to avoid injuring the intima, only a small filamentous clot was extracted. I thought then of re-establishing a provisional channel at the expense of the vessel coats (reconstructive endo-aneurismorrhaphy) but the relative freedom of the posterior tibial, as shown by the pulsation before the operation, led me to decide for the obliterative procedure. The orifices were, therefore, sutured separately, and the sac was completely obliterated with buried rows of iodized gut and closed without drainage. On removing the constrictor, the hyperæmic wave was long delayed, fully half a second, when it came with a rush down to the tuberosity of the tibia, then very slowly it progressed a little further, becoming paler as it went on to the middle of the leg and stopped The lower leg and foot were waxy, cold, and cadaveric. No pulse at the posterior tibial; no sign of life.

We endeavored to encourage the hyperæmia by pouring hot water and bathing the limb in a hot salt solution, but to no avail. I was beginning to despair after waiting an hour, and was seriously thinking of reopening the sac and attempting extirpation of the sac and venous transplantation, when it appeared to me that

the nails showed a pale trace of color and that the pulps of the toes were less waxy. The wound was dressed and the limb copiously padded with cotton wadding and put on a posterior gutter splint, with a separate dressing, to allow easy inspection of the toes. The patient, who had not lost a drop of blood in the operation, was in excellent condition, with a slow, full pulse; nevertheless, I ordered hypodermics of strychnine and digitalin, with enemas of black coffee, diluted in saline solution, and given as a Murphy drip. All this was done with the idea of increasing arterial tension, creating a hypertension, if possible, to strengthen the systolic wave and force the collaterals. As soon as the patient recovered from the anæsthetic, which he did promptly, the whole leg was placed in a hot air apparatus, in this following the suggestion of Ropke "Aktive Hyperæmie in der behandlung arteriosklerotische Gangran" (*Münch. med. Woch.*, 1907, No. 14), who has obtained good results in stimulating the collateral circulation by inducing active hyperæmia with hot water bags.

After this treatment, the limb was kept quiet and warmed with large hot water bags. The patient at first stated that his foot felt dead; shortly after the hot air treatment he complained of severe burning pain, especially in the heel and toes, and in two hours he expressed himself as quite comfortable. After two hours of great anxiety, the foot was examined and found to show some color, though still quite pale; by night it was warm and sensitive, with a marked return of the plantar reflexes.

Next morning the foot looked normal, though neither pulse at the ankle could be felt. On the eighteenth day after the operation, the patient was discharged and returned to his home in Greenville, Miss., with his wound completely healed, able to walk, and with good control of the extremity.

I have consumed some time in the description of this case, because it teaches at least two lessons: (1) that the hyperæmic reaction as applied in testing the collateral circulation in peripheral aneurisms is reliable when applied in conditions which permit the observer to gauge the efficiency of the compression by the state of the peripheral pulse; (2) that notwithstanding its simplicity, it is not free from risk. This risk, however, is common to all diagnostic and therapeutic methods which arrest temporarily the circulation of the blood in the

aneurismal sac. In any ordinary examination of an aneurism by digital compression, the temporary suppression of the circulation by applying the finger to the main artery on the proximal side is followed by a rush of blood into the sac when the pressure of the artery is removed. This usually is followed by no evil consequences, but it is easy to conceive that in individuals with highly coagulable blood, the temporary stasis of the blood in an aneurism may favor the formation of soft coagula or passive clot, which may be easily washed into the outlet, as emboli, with the next stream of blood that is pumped into the sac after the release of the proximal pressure. This risk is no doubt greatest in sacs which already contain a considerable amount of soft clot, and is also more liable to occur in fusiform aneurisms in which the inlet and outlet of the sac lie on the same level.

The sacciform aneurisms, with a single opening or communication, are, for obvious reasons, less liable to this accident, and the fusiforms, with openings at different levels, are safer from this point of view. But, since the type of sac can never be determined until the aneurism is opened, we cannot foresee in what particular case this contingency may arise. On the other hand, the same embolic phenomenon accounts for the occasionally and equally rare cures of aneurism which occur after a single brief interruption of the current effected by the finger of the examiner, who is merely investigating the case for diagnostic purposes. Cases of gangrene of the leg and toes after digital and instrumental compression (Reed's method), etc., in which the aim of the surgeon was to favor the coagulation of the sac contents by arresting the circulation temporarily, were not at all rare in the days when these methods were in vogue. And it is precisely because the clot is completely removed, and the sac is so thoroughly emptied in the operation for the cure of aneurisms by the intrasaccular suture method, that this method may claim a decided advantage over the ligature and the older methods.

It is evident, however, that there must always be some risk of peripheral gangrene by embolic or thrombotic obstruction in the sac or beyond it, regardless of any method of treatment

adopted. The proof lies in the fact that cases of spontaneous gangrene of the foot and leg, caused by aneurism, especially the popliteal, are not of extremely rare occurrence, as is shown by the numerous references in the literature. I have seen three such cases. The displacement of emboli from an aneurismal sac is one of those risks which is clearly unavoidable. It is fortunate that such occurrences as I have described in my case are extremely rare. The essential question is: Does this possible, but exceedingly improbable, occurrence of peripheral embolism argue against the application of the hyperæmia test, as I have described it? Does the risk of a possible embolus outweigh the great advantage to be obtained by a better knowledge of the efficiency of a collateral circulation as a preliminary to a radical operation? I think not. After considering the facts before me, I will not hesitate to avail myself of this most valuable and practical method of exploration in cases that may in future come under my observation. I must continue to regard it as a most valuable asset in the investigation of the collateral circulation. In connection with the risk of embolism, I feel that in addition to the advantages of the apparatus I have described in testing the efficiency of the collateral circulation, it is possible that it may be utilized to advantage in developing the circulation when this is deficient, as shown by the test. The Japanese (Kókuzi, Saigo, Tanaka), with their very large experience in traumatic aneurisms, as a result of their late conflict with Russia, believe in and recommended the systematic compression of the main trunk to develop the collateral circulation some time, days or weeks, before a radical operation. If it is comparatively easy to determine the efficiency of the collateral circulation by the hyperæmia reaction in the manner I have suggested, it will also be a simple matter to watch the improvement in the collateral flow by the re-application of the same test.

During these periods of observation and before beginning any investigation of the collateral circulation by a method that must necessarily interrupt the blood current in the aneurismal sac, it may be advantageous to obtain some information on the coagulability of the patient's blood.

The coagulation of the blood could be easily determined in every case by Wright's method, so that if the coagulation time is shortened, proper methods of treatment may be instituted which may tend to diminish the coagulability and thereby lessen the risk of embolus. Contrary, therefore, to the older practice, which strained every effort to induce coagulation in the sac as a means of cure, subjecting the patient to a reduced dietary with almost a total suppression of water (Valsalva, Tuffnel, Billingham), and bleeding to increase the fibrin content of the blood, we would adopt the opposite plan, which is to supply an abundance of fluid, allowing the patient to drink freely of citric acid lemonade or solutions of the acid citrate of sodium, as suggested by Wright in neutralizing the increased coagulability of the blood and the tendency to thrombosis, observed in the febrile infectious diseases (typhoid, etc.). Following Wright's suggestion again, these patients should not, during the period of observation, be given milk, as it has a large calcium content which favors coagulation. It is only in the inoperable and inaccessible internal aneurisms that the methods which favor the formation of clot in the sac are justifiable.

I believe I have said enough to direct your attention to at least three propositions: (1) that in the treatment of the surgical or operable aneurisms of the extremities, a preliminary knowledge of the resources of the collateral circulation is very desirable, if not absolutely necessary, in view of the possible obliteration of the main trunk in the course of the intervention; (2) that in the modification of the "hyperæmia test" which I have described, and which has thus far satisfied my clinical needs (in so far as the peripheral aneurisms of both extremities are concerned), we have a simple, practical means of obtaining approximate, pre-operative information in regard to the status of the collateral circulation; furthermore, (3) that the same method may prove of value by systematic compression of the main trunk, in developing the collaterals when these are found deficient. Finally, while fully realizing that the suggestions embodied in this paper represent only a crude

and unfinished effort to solve a really important problem, I merely submit it for discussion and further investigation, hoping that the simplicity and ready application of the method proposed will commend it to the attention of practical surgeons.

II.

So much, then, for the peripheral aneurisms of the extremities in which the main trunk of the limb on the proximal side can be compressed; but how about the aneurisms of the iliofemoral and iliac groups and those of the aortic bifurcation below the renals? How about testing the collateral circulation in the innominate and subclavian tracts? How about the still more dangerous aneurisms of the common and internal carotid trunks? These are all separate and distinct problems, but of varying importance from the point of view of the collateral circulation.

Thus, the obliteration of the iliac trunks, from the bifurcation to Poupart's ligament, is fraught with much less peril of peripheral necrosis than the ligation of the vessels below the groin. In the upper extremity, the importance of the collateral circulation from the point of view of necrosis is still less urgent. In the neck, the carotid tracts offer the gravest problems in the way of determining the efficiency or deficiency of the collateral circulation in the circle of Willis. However, I am glad to say that the obstacles in the way of a preliminary test of the circulation and the viability of the distal parts, after the occlusion of these great trunks, are not insuperable with the technical resources now at our command.

In previous publications (see "Statistics of Endo-aneurismorrhaphy, etc.," *Jour. Amer. Med. Assoc.*, November 14, 1908, li, pp. 1667–1671; Keen's *Surgery*, v; *Surgery of the Arteries*, "Carotid Aneurisms"), I have already referred to the importance of testing the collateral circulation in dealing with all operations on the neck, including all tumors, malignant neoplasms, which in the course of their extirpation or surgical treatment might require the obliteration of one or both carotid tracts (common and internal carotids especially).

A long and abundant experience with the surgery of the

carotid artery, amounting in a period of twenty-five years to over 78 ligations and extirpations of the common trunk and its two branches, has fully convinced me that the risk of fatal intracranial and cerebral complications resulting from an insufficient collateral circulation are not to be underestimated. Entirely apart from the secondary risk of sepsis, the immediate dangers of cerebral ischæmia deserve the most serious consideration on the part of the surgeon.

In the surgery of the arterial trunks of the neck more than elsewhere in the body, I have felt the need of some preliminary information as to the adequacy of the cerebral circulation before undertaking any operation which might involve the permanent and unavoidable obliteration of one or both carotid tracts. The need of some test has been more acutely experienced in recent years since the surgery of the neck has become far more aggressive than in the past. I have elsewhere referred to the stimulating work of W. S. Halsted, Crile, Jordan (of Heidelberg), Doberauer, of Saiger, and of Riess and others who have demonstrated, in a conclusive way, the tolerance of the large arteries to prolonged occlusion with various compressing agents (metal clamps, aluminum bands, rubber bands, etc.). The work of Scarpa, Porta, and other old masters, undertaken chiefly with the view of gradually obliterating the vessels, could not be carried to a successful termination in the state of surgery at the time. At present, the aseptic healing of wounds has placed the behavior of the occluded arteries in an entirely new light, and the result of our own personal investigations, stimulated chiefly by the experimental and clinical work of Dr. W. S. Halsted with his aluminum bands, is convincing of the great value of preliminary occlusion of the blood-vessels with removable metallic bands, as a prophylactic against cerebral complications and peripheral necrosis in other parts of the body. This procedure might well be called "prophylactic occlusion of the arteries" whenever an occluding agent is applied to a blood-vessel with the intention that it interrupt the flow of blood in the vessel provisionally without injuring its walls. This means that if untoward symptoms or signs of peripheral ischæmia should manifest themselves in the

brain or other distal parts, it will be possible, within a reasonable time, to remove the occluding agent (we have in mind a metallic band) and allow the circulation to be restored through the previously occluded artery. This preliminary "test occlusion," with the help of aluminum bands, block tin, or other soft metal, should, if possible, always be tried with local anæsthesia. In dealing with carotid aneurisms, it is important that this preliminary occlusion be made while the patient is fully conscious in order to obtain prompt information of the cerebral effects of the interruption of the blood current in the brain, as these manifestations often appear the moment the occlusion takes place. More often, a period of six, twelve, thirty-six hours, days, and weeks may elapse before the cerebral disturbances show themselves.

Those who are familiar with Dr. Halsted's masterly contributions on this subject will at once recognize the nicety and beauty of the special and ingenious technic with the rolled aluminum band, which he devised in 1905 and has since perfected.[3] Unfortunately, however, to roll an aluminum band with perfect accuracy around an artery requires a special curling device which is not always available, and, what is more, requires a very considerable experience in adjusting the band, which all do not possess. Dr. Halsted's chief purpose in using these bands has been to obtain a *gradual* obliteration of the arteries, so that coagulation might be favored in treating the more dangerous aortic and other usually inoperable aneurisms of the neck and splanchnic cavities. His aim has also been to obtain by *gradual* occlusion, a secondary development of the collateral circulation in parts liable to suffer by insufficient vascular supply.

The idea here advocated is that of an *immediate* and *total* occlusion as distinguished from a *gradual* obliteration, with the view of determining the sufficiency of the collateral circulation as a preliminary to a permanent obliteration of the involved vessels. For this purpose, I first applied a simple self-retain-

[3] W. S. Halsted: "Partial, Progressive, and Complete Occlusion of the Aorta and Other Large Arteries in the Dog, by Means of the Metallic Band," The Journal of Experimental Medicine, 1909, xi, 373 *et seq.*

ing aluminum band, which occluded the artery by merely flattening it without constricting its walls (Figs. 4 and 5). This band could remain and heal in the tissues as any ordinary aseptic ligature, but could be removed at any time that it might be deemed necessary to do so. With the help of my assistants I experimented with several models, but finally concluded, after various experiments, in favor of the simple, flexible aluminum band which my friend and energetic assistant, Dr. Carrol W. Allen, carried out on a large scale on dogs. The bands may be pressed and kept in place by the fingers. The application of these bands is so simple that they are even easier to apply than a ligature; they stay in place perfectly, are capable of nice adjustment, do not crush the artery, and are tolerated perfectly by the tissues.

We have applied these bands in seven cases in which the subclavian and carotid tracts were involved. The bands have been used either as a prophylactic test of the collateral circulation in dealing with tumors preparatory to extirpation, or in treating aneurisms on the Brasdor plan (Guinard's operation). The chief purpose of the experimental inquiry conducted under my direction by Dr. Allen has been to determine the length of time that an artery, such as the carotid, subclavian, or femoral, could be occluded without permanently damaging or obliterating its lumen. What is the utmost limit of time that an occluding metallic band can be kept in position before permanent damage, leading to thrombosis or embolism, occurs in the intima? What are the changes that occur in the vessel after occlusion has been maintained for a certain number of hours or days, at the time of the occlusion, and after the occluding agent has been removed? What kind of material is best suited for occlusion of the arteries, combining the features of tissue tolerance, facility of application, and ease of removal with the minimum of trauma to the artery?

To answer these questions, the femoral and carotid arteries of dogs were used. Dr. Allen performed 168 experiments on 42 dogs, but this number of experiments was reduced to 43 available results by infections, deaths, and escapes of the animals. These 43 experiments may be grouped as follows:

In 7, the artery was occluded two days; in 14, three days; in 8, five days; in 4, five days; and in 3, six days. In 22 of these cases the vessel and band were excised together at the stated period of observation, and in 21, the clamp or band was removed, the vessel remaining *in situ* to be excised subsequently. After the removal of the vessels, the gross and histological changes were noted and photographs made, showing the condition of the artery at the seat of the occlusion. Three forms of bands were first used, all about as wide as one diameter of the vessel operated upon: (1) a band made of silver wire, in which the wires were held flat and in a single parallel row by soldering the strands together; (2) thin aluminum bands, held in place by clamping the free ends with a lead clip; (3) another aluminum band much thicker than the preceding, and thick enough to maintain a pressure sufficient to occlude the vessel without a clip, when once moulded and adjusted to the vessel with the fingers. The silver wire bands which I had previously used in two distal ligations of the carotid and subclavian were soon discarded for the aluminum bands, and, of these, a thicker kind (No. 14 to 16, Brown & Sharp's sheet-metal gauge)—which retain their hold on the artery without the lead clips—were preferred and have been used since in nearly all the experimental and clinical work. These bands are stiff and are cut into strips long enough to be used as an aneurism needle, by bending and curling one end in the shape of a blunt hook which can be readily insinuated between the blood-vessel and the sheath after preliminary dissection (Fig. 5).

After the band has been carried around the vessel, it is compressed between the fingers of the operator until the pulse on the peripheral side becomes imperceptible. The excess of band which remains is cut off with short, sharp scissors, or preferably with a small wire clipper.

If it should become necessary to remove the band at any time on account of disturbance in the territory supplied by the vessel (cerebral disturbances, threatened gangrene of the toes or digits), the wound can be reopened, and with the point of a sharp instrument inserted between the approximated edges of

the band and slightly twisted, their separation will be accomplished with immediate release of the vessel. Some of these bands have been removed after periods of time varying from four to eight weeks, the specimens having been obtained from patients who had succumbed from the effects of inoperable aneurisms of the innominate, right carotid, and ascending arch. The perfect tolerance of the tissues from suppuration and from secondary hemorrhage was demonstrated in all; the bands remaining encysted in a ring of organized exudate without causing the slightest irritation.

The following are the conclusions arrived at:

1. It is possible to compress a vessel to the point of obliterating the pulse and maintain this pressure for a period of from three to four days, before adhesive or obliterative changes in the intima occur.

2. All the vessels clamped in this manner stood compression seventy-two hours without apparent microscopic change in the intima; some few began to show marked changes in ninety-six hours.

3. There is apparently no reason why, in occluding the great vessels at the root of the neck, chest, and lower abdomen in continuity, these removable bands should not be substituted for the circular ligature, which permanently damages the artery, even when carefully applied. Furthermore, the ligature does not permit of the release of the constriction after a few hours or days of observation without certainty of thrombus formation at the seat of the ligation.

4. In view of the preceding statements, it would seem to be logical to utilize the simple method of occlusion as a preliminary test of the efficiency of the collateral circulation in all regions in which the hyperæmia test, as previously described, is not applicable. A brief statement of this research was presented at the meeting of the Society of Clinical Surgery last November (1909) at Rochester, Minnesota. Since then, more experimental work has been done, and a careful histological study of the specimens removed has also been conducted with the assistance of Dr. Gurd, of the Laboratory of Surgical Pathology of Tulane University.

ANATOMICAL AND SURGICAL DESIDERATA IN THE EXPOSURE AND REMOVAL OF THE PITUITARY GLAND.

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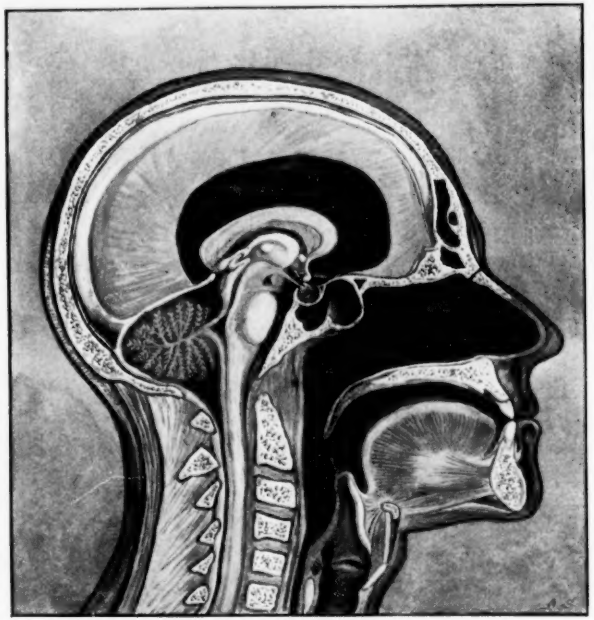
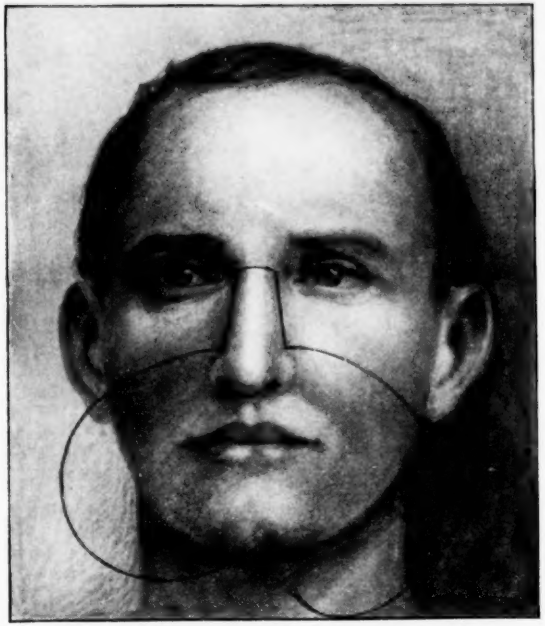
AN anteroposterior section of the head shows that the roof of the nose, when compared to the parts situated anteriorly and posteriorly to it, corresponds, on the one hand, to the depression at the root of the nose, and, on the other, to the uppermost part of the sphenoidal sinus, the anterior wall of which slopes down posteriorly and forms the upper half of the posterior wall of the nasal cavity (Fig. 1). Hence, to expose the sphenoidal sinus, an incision at the root of the nose and from there downward is sufficient and renders opening of the frontal sinus unnecessary. The entire height and width of the interior of the nasal fossæ can be exposed by turning the nose downward. An incision is made on either side, starting below at the widest part of the bony nasal aperture (pyriform fossa) and passing upward to the depression at the root of the nose. These two incisions are united by a cross incision, the scalpel passing through all the tissues down to the bone (Fig. 2). The periosteum of the osteoplastic flap is not interfered with, but that lying opposite it pushed backward toward the face only enough to accommodate the width of a Gigli saw, which is now used, beginning with a cut at the root of the nose to form a groove (which will fix the saw for its downward course) and then continuing through the bone freed of its periosteum until the lower end of the incision has been reached. A retractor, grasping the flap above and drawing it forward, will open a cleft into which a scalpel can be introduced to complete the separation of the cartilage of the septum sufficiently to permit complete depression of the nose, thus exposing the full height

FIG. 1



Anteroposterior section of head.

FIG. 2.



External line of incision, showing extent to which bones are divided by the Gigli saw.

and width of the nasal fossæ. The hinge of the soft part, which remains below, contains the terminal branches of the facial arteries, which will nourish the osteoplastic flap thus formed. With curved scissors directed along the roof of the nose, the septum can be severed superiorly and posteriorly along the sloping anterior wall of the sphenoidal sinus. In order to facilitate the grasping of the bleeding vessels, ½ centimetre of the septum should be left standing above while posteriorly it is cut close to the sinus wall. To expose this anterior wall of the sinus, straight scissors should now be used to cut the septum, from below and in front, upward and backward to the middle of the posterior wall of the nasal cavity. A wedge-shaped section of septum is thus removed, producing a funnel-shaped cavity, the opening of which corresponds to the outer border of the nasal cavity and the smaller end to the anterior wall of the sphenoidal sinus, which must be removed. Only in the event of protruding middle turbinals and prominent lateral masses of ethmoid cells should these be interfered with. This is best done by cutting away the turbinals with straight scissors and removing the cell masses by means of a bone curette or forceps. A greater resistance present after ethmoid cells have been removed indicates the orbital plate. The same resistance is met at the roof of the nose and acts as a barrier, preventing exposure of the dura.

After the anterior wall of the sphenoidal sinus is removed by means of chisel and bone-cutting forceps, the prominence on the posterior wall becomes apparent. This prominence is the depression caused by the floor of the sella turcica, and that part of it corresponding to the median line of the skull must be removed to reach the pituitary gland. Oftentimes the septum between the sphenoidal sinuses is irregularly placed to one or other side of the median line of the skull, or starts on one side or other above and runs to the opposite side below; frequently it is entirely absent. Therefore, to expose the pituitary body, it is essential to choose the median line of the skull, not permitting the irregularly attached sphenoidal septum to detract from removal of the midportion of the prominence

on the posterior wall of the sinus. This should be confined to the central portion to avoid injuring the cavernous sinuses and carotid arteries on either side, and a button about half a centimetre in diameter should be removed with a trephine or a long-handled gouge, its concave surface directed toward a central point. For a decompression operation to relieve the tension of a tumor, more of this posterior wall must be removed. After the bone corresponding to the floor of the sella turcica has been removed, the cavity is recognized by probing, the resistance of the posterior wall of the sella turcica (dorsum sellæ) indicating the exact location of the cavity sought for. Removal of the gland can be accomplished by means of a long-handled scoop or curette.

The purpose of the procedure having been accomplished, the nose is brought back into place and secured by several sutures for the deeper tissues and periosteum and finally some for the skin. In this way the greater part of the interior of the nasal cavity remains intact and the part sought for is completely exposed, illumination of the depth of the cavity being accomplished by means of a head light or an electric pencil directed to the field of operation.

THE TREATMENT OF X-RAY ULCER.

BY RAYMOND C. TURCK, M.D.,
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X-RAY ulcer cannot be classed pathologically as true ulcer. The lesion is exceedingly complex and partakes of the characteristics of a tissue necrosis, a gangrene, and a fibrosis.

Burdick, who has had a large experience in the treatment of this condition, believes it to be a white gangrene. The lesion, if left to itself or if treated by any of the ordinary methods, follows a fairly typical course, varying only in the length of time covered by the different stages.

There is, first, a slight dermatitis or erythema at the site of the exposure; this appears usually in from two to three days, though cases are recorded in which the primary dermatitis did not develop until the end of the third week. Vesicles and pustules then appear in the erythematous area, with pigmentation and loss of hair. Ulceration and sloughing soon begin in the centre of the inflamed patch and extend concentrically outward. After the superficial necrotic tissue has sloughed off, a foul, dirty gray ulcer is left, the base of which is composed of a leathery fibrous tissue, exuding a foul, viscid, yellowish secretion. If operative measures are not resorted to, this condition may persist for months or years; may terminate fatally; may become the seat of an X-ray carcinoma, or after a varying period of time, may cure spontaneously by sloughing away of the thick fibrous base and healing of the resultant wound by the ordinary process of granulation. The site of an ulcer spontaneously healed is always tender and irritable, and is frequently the seat of small necrotic areas, which in turn may slough, granulate, and eventually heal.

The two most striking features of an X-ray ulcer are its absolute resistance to any ordinary medicinal treatments or

dressings and the excruciating pain which accompanies it. Burdick thus described the pain of fairly typical cases:

"The pain from an X-ray burn is very characteristic. It has no other analogue in medicine. We may have the smarting, itching, and radiating neuralgia pains for a few weeks, until it is evident that necrotic tissue is present, when the pain becomes an agony. . . . It will last ordinarily as long as the gangrenous tissue is in the wound and stop upon its removal."

"After the wound is cleaned up by curettement, relief from pains may last for a few days or weeks; eventually the pains recur with this variation: they are paroxysmal in character, coming on several times in twenty-four hours and lasting for an hour or more, when they leave as suddenly as they came. The patient is perfectly comfortable between the attacks and feels as well as he does in general health."

Emphasis should be laid upon the fact that the pain ceases and healing begins only after the fibrous or gangrenous base of the ulcer has sloughed away, or after it has been cut out.

No form of applications, ointments, powders, wet dressings, or local anæsthetics exerts the slightest influence upon a well-developed X-ray ulcer, either in the mitigation of pain, or in the healing process. Indeed, any kind of medicated application seems but to aggravate the patient's pain, and morphine hypodermatically must always be employed.

In the case herein reported it was determined to thoroughly remove all of the fibrous base of the ulcer and skin graft the surface after new granulation had formed.

I proposed to use the method of skin grafting reported by Dr. John S. Davis in ANNALS OF SURGERY for March, 1909. Davis advises the application of a splint after the grafts are in place. His splint is made from a coarse curtain mesh, which after being washed and dried, is soaked in a solution of pure gutta-percha 30 parts, chloroform 150 parts. After the chloroform evaporates the curtain mesh is left with some stiffness. The mesh is sterilized by washing in a 1 to 1000 solution of bichloride, and is kept permanently in

a jar of the same solution. In Davis's method, after Thiersch grafts are in place, the splint is rinsed in salt solution and applied, lapping well over the edges of the grafted area, and fastened in place with adhesive straps which should not extend upon the raw surface. The advantage of this splint lies in the fact that the grafts do not stick to the dressing nor does the granulation tissue grow into the mesh. Davis recommends a first dressing in from thirty to seventy-two hours; the gauze next to the mesh being well soaked in salt solution before removal, and care taken that the mesh is not pulled up from the grafts. The grafts may then be irrigated and a fresh dressing applied over the mesh.

Unfortunately, I was unable to procure any pure gutta-percha in time to prepare this splint, so I used a curtain mesh soaked in a 5 per cent. solution of celloidin and sterilized, after drying, by immersion in a 1 to 500 bichloride solution. While this worked out very satisfactorily, yet I believe the splint prepared with gutta-percha to be much superior.

Case I.—The patient is a white male, age thirty-six. In October, 1908, he contracted syphilis with a well-defined chancre. The secondary eruption appeared in December. In the latter part of December, 1908, he had an attack of acute jaundice, which confined him to his bed for a month. This culminated in localized pain in the right iliac fossa, which was diagnosed as acute catarrhal appendicitis.

In February, 1909, he appeared at the office of a specialist in electrotherapeutics, stating that he had read in New York papers of the benefit of X-ray treatment for catarrhal appendicitis, and asked for treatment. He was advised regarding the danger of a burn, particularly since he was suffering with secondary syphilitic eruption, but he insisted upon taking the X-ray treatment, if there was a possible chance of relieving him of the pain. He was further advised that the chances of benefiting appendicitis with the X-ray were small.

Under protest, however, the specialist, a skilled and experienced X-ray operator, consented to give him a few treatments and to carefully watch the results. He was given for four weeks tri-weekly exposures, each of five minutes' duration, with the

tube placed fourteen inches from the abdomen. Registered penetration No. 6. The pain in his right side subsided and after an interval of a week he was given three more four-minute exposures with the same tube, same distance and penetration. Two weeks after the last exposure the first symptom of a first degree burn appeared. This was treated with normal salt solution. The erythema extended from his groin to within one and one-half inches of his navel, causing him but little pain or discomfort at that time. The area of dermatitis was apparently disappearing when a necrotic area, about two and one-half inches in diameter, appeared in the centre. After the necrosed skin had sloughed, this area assumed a tough, leathery appearance and became very painful. He was put to bed and local applications of ointments, powders, and wet dressings applied. The pain became intense, necessitating from one-half to one and one-half grains of morphine per day. The ulceration gradually became deeper and wider in area, with pains apparently increasing in proportion to the spread of the necrosis.

At this time, April, 1909, the patient was referred to me for treatment. I found a foul, sluggish ulcer about five inches in diameter situated upon the right side of the abdominal wall, extending from a line an inch above the navel nearly to Poupart's ligament. I first did a superficial curettage under local anæsthesia on April 28, 1909. The pain was terrific. A formadine dressing was applied. Following this there was some epithelial growth from the skin edges; no granulation, however, upon the scar tissue.

There being no improvement and the pain still continuing, he was advised that a thorough removal of the necrotic area, with subsequent skin grafting, offered him the best chance for recovery. He was accordingly sent to St. Luke's Hospital, and on April 29, 1909, under ether anæsthesia, the edges of the ulcer were thoroughly curetted and the firm, leathery base of the ulcer was entirely removed down to normal bleeding tissue. The fibroid base was in some places nearly three-quarters of an inch in thickness, and extended in some instances well down into the rectus and external oblique muscles. Strands of fibrous tissue were also radiating from the main fibrous body into the fascia and musculature. Hemorrhage was controlled by hot saline packs. The wound was dusted thickly with aristol. On the

second day a wet boric dressing was applied and continued until the skin grafting operation, May 6, 1909.

Four hours before the grafting operation, the boric dressing was removed, the wound was irrigated, and a wet dressing of 1 per cent. formalin solution applied. The formalin dressing was removed after anæsthesia and the granulating surface irrigated with normal salt solution. The granulation tissue was then lightly shaved with a razor, and after controlling all oozing with hot saline packs, the area was covered with small Thiersch grafts taken from the patient's thighs. The wound was then dressed with the celloidin meshed splint. Over this were placed several layers of gauze saturated with normal saline solution, and the whole covered with rubber tissue.

There was a great deal of secretion. The dressings were removed down to the splint on the fifth day and wet boric dressings applied. Secretion was profuse. The splint was removed at the end of the tenth day and the grafted surface dressed with sterile boric ointment and gauze. The ointment was warmed so that it would flow in liquid form. It was then poured upon the grafts and allowed to harden to its normal consistency. This treatment was continued until May 24, 1909, when the area was nearly covered in and doing nicely. On June 15 the wound was entirely healed and the patient left the hospital. The boric ointment application was continued until August, 1909; the patient, however, began doing light work after July 1. The scar has given no trouble and has been at all times perfectly solid. There has been no pain since the first removal of the fibrous tissue.

Histopathologic Findings.—Vertical sections were made from the centre and margins of the ulcer base.

All layers of the epidermis as well as the papillary layer of the skin were absent.

Upon the upper surface a few chromatophores and numerous polynuclear leucocytes were found.

Blood-vessels and lymph-channels were few and atrophic. Occasionally the remains of a sweat duct was observed, the epithelia atrophic or lacking; here and there desquamated and blocking the lumen. The fibrous sheaths of the ducts were much thickened.

There were no hairs, hair follicles, nor sebaceous glands.

Just below the surface, and about the atrophic vessels, sweat-glands, and ducts, there were numerous dense cell infiltrations.

These cell infiltrations were made up of plasma cells, polynuclear leucocytes, and small lymphocytes, the latter predominating.

The collagen bundles were in part swollen and translucent, in part replaced by old white fibrous tissue with slender pycnotic fibroblasts, their nuclei often irregular and distorted.

Areas of infiltrating cells (mainly small mononuclears) and much glassy or adult fibrous tissue were found in the depths of the specimen.

The intracellular tissue between the fat cells of the subcutis was much thickened, and new fibrous bands could be seen extending downward and in all directions.

The few vessels showed obliterating changes, both media and adventitia being greatly thickened, and the vessel lumen being decreased irregularly by the distorted endothelia.

The muscle nuclei of the arterioles were pycnotic and distorted.

The perineurium of the nerve-fibres was also thickened; there was in addition a chronic interstitial fibrous proliferation in the nerve, with a few polynuclear leucocytes in the nerve-fibres.

The fibrosis was general, disposed in trabecular and retiform arrangement.

POSTERIOR GASTRO-ENTEROSTOMY, THREE YEARS AFTER ANTERIOR GASTRO-ENTEROSTOMY.

BY M. A. FAUNTLEROY, M.D.,

Surgeon in the United States Navy.

THIS man, whose case is given below, has the unusual distinction of possessing two gastro-enterostomies, one anterior and one posterior, the latter having been performed three years after the former.

H. A. W., unmarried, age 22 years and eleven months. Case paper No. 275, U. S. Naval Hospital, Philadelphia, Pa. Admitted from the U. S. S. *Lancaster* on October 8, 1910, with a diagnosis of gastric ulcer.

Has always been in robust health up to the age of seventeen, when he began to have a more or less continuous localized epigastric pain in the midline. He dates this trouble from a time when he was lifting a heavy weight, causing, as he states, a lump to appear to the right of the umbilicus, which, however, shortly passed away and has never reappeared. Pressure over the epigastric region intensified the pain, and at this time the pain was present at practically all hours of the day and night so that he could not sleep.

He was transferred to the U. S. Naval Hospital, Annapolis, Md., in April, 1907, with a diagnosis of gastric ulcer, having vomited blood very copiously just before transfer to the hospital. Nothing further is noted on the patient's case paper at this time except that the pain continued, requiring at times morphia, and that he was becoming progressively thinner. In July, 1907, an anterior gastro-enterostomy was performed at the U. S. Naval Hospital, Annapolis, Md., and a Murphy button was used to effect the anastomosis. There was marked improvement after the operation, there being a cessation of all pain, and when the patient was discharged to duty four months later he had gained 36 pounds. Shortly after he had been discharged he contracted

scarlet fever, from which he made a complete recovery. The patient's case paper further states that at the time of his discharge to duty after operation the Murphy button had not been passed, and that several skiagraphs taken at this time showed the button in position.

Patient was free from all symptoms until the latter part of September, 1910, when the pains began to return about an hour after eating meals; these pains were relieved by taking bicarbonate of soda. On the morning of October 8, 1910, there was a moderately severe hæmatemesis and he was transferred to the U. S. Naval Hospital, Philadelphia, Pa., for further treatment.

On admission to this hospital he was slightly emaciated, but with fair color. There was no pain or tenderness even on deep pressure in the epigastric region. On the evening of the day of his admission he had a rather copious hemorrhage from the stomach and another on the evening of October 9. In the early morning of October 11, there were two very copious hemorrhages, and a stool passed at this time was black and tarry. There was still no pain and the patient's belly was abnormally flat. The vomited blood in each instance was markedly acid. At this time there was marked pallor and weakness with a pulse of 126, and immediate operation was decided upon and the patient prepared accordingly.

Operation.—Ether anæsthetic. Before the anæsthetic was started the right median cephalic vein was opened and salt infusion begun. This was kept up during the entire operation, 2200 c.c. being introduced in all. An incision was made to the right of the old scar and the abdomen rapidly opened, from the ensiform cartilage to eight inches below. On opening the abdomen and viewing the parts, there was seen a more or less conglomerate mass, consisting of omentum and small intestine which seemed to be glued together over the region of the stomach. These adhesions were carefully and slowly broken up with the aid of a gauze pad, and only once was it necessary to use the scissors. In this latter instance there was a broad, dense, as well as short, band of adhesions which anchored the upper anterior part of the stomach to the diaphragm. This was carefully snipped away and a few bleeding points ligated with small silk. On the removal of this band of adhesion the stomach

was more plainly visible and allowed of much freer manipulation. After about 20 minutes of separating adhesions, the former anterior gastro-enterostomy was plainly made out and the limbs of the gut identified.

The entire stomach was carefully palpated with the idea of possibly locating the indurated margin of an ulcer, but no spot could be incriminated as a possible bleeding point. The stomach was about three times as large as normal, and the pylorus and upper duodenum were dwarfed and thickened. It could be plainly seen from the high position of the former anterior anastomosis that the stomach was not being drained properly since clotty blood could be felt through the stomach walls below the level of this anastomosis. In view of the above, it was decided to perform a posterior gastro-enterostomy in the most dependent part, including a part of the greater curvature as recommended by the Mayos. The greater omentum was ligated and removed for a distance of three inches along its attachment to the greater curvature, and the lines of the gut leading from the old anterior anastomosis were selected to form part of the new posterior anastomosis. An opening was made in the gastrocolic omentum by blunt dissection, and the lower posterior surface of the stomach pushed through from behind. Moynihan's clamps were used, and a three-inch incision was made in both stomach and intestine after the clamps had been secured in position and after the posterior seromuscular silk suture had been placed. The intestinal and gastric mucous membrane was trimmed and sutured together with silk, and the posterior seromuscular suture continued around to form the anterior seromuscular suture in the usual way.

After the patient had recovered from the ether he was placed almost in Fowler's position, with the idea of encouraging the complete drainage of the stomach through the large new opening. The after-treatment consisted of nothing by the mouth for five days, during which time the only nourishment he received was 500 c.c. of salt solution by rectum every six hours. At the end of this time small feeds of peptonized milk, chicken broth and albumin water were allowed every two hours. These were borne well and gradually increased, until at the present time (38 days after operation), the patient is practically on full diet and has been walking out in the hospital grounds for the past

week. The first few days after operation the patient complained of great thirst, but with this exception and a slight post-operative rise of temperature he has not had an untoward symptom. His bowels move regularly and are of normal color and consistence.

This case illustrates in a striking manner the importance of securing prompt and efficient drainage where copious hemorrhage from the stomach is a prominent feature, and it is believed that an early operation is indicated where the first few days of medical treatment apparently have no effect on the outpouring of blood in the stomach. The gastric juice drains off immediately and does not digest an existing ulcer or denuded surface, and it is also believed that there is a contraction of the organ with a consequent arrest of hemorrhage. No Murphy button was found at the site of the old anastomosis and it was doubtless passed without the patient knowing it.

NON-PROSTATIC URINARY RETENTION OF THE SENILE BLADDER.*

BY MARTIN W. WARE, M.D.,

OF NEW YORK,

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WHENEVER we are confronted with an aged patient afflicted with dysuria characterized by complete or incomplete retention with or without incontinence, pollakiuria, increased ardor urinæ, or retarded urination, we are wont in text-book-like fashion to placate the lesion, either as an intravesical mechanical obstruction, or attribute it to a lesion of the vesical central nervous system. An ever-increasing report of cases, which, however, do not fit in either category, is very evident from a perusal of the literature, and warrants a consideration of this subject, which was prompted by an experience with such similar cases.

J. B., No. 115,543, June 15, 1910, aged seventy years, was admitted to the medical service of Mt. Sinai Hospital for emphysema and myocarditis. During the two weeks that he was an inmate, it was noticed that he was incontinent. For this dysuria, he was referred to the Genito-Urinary Service, with a tentative diagnosis of hypertrophied prostate.

Status Præsens.—A very aged appearing man, blunted sensibility, though conscious, and somewhat deaf. The vessels generally atheromatous. Heart sounds dull and muffled and distant, and an occasional systolic murmur at the apex.

Rectal Examination.—External hemorrhoids. Palpation revealed a prostate not enlarged but moderately firm and not tender. Percussion of the abdomen showed the bladder dulness reaching three finger-breadths above the pubis. The patient was unable to void. A soft (Nélaton) rubber 20 F. catheter entered easily, and 720 c.c. of clear urine were withdrawn.

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* Read before the Genito-Urinary Section of the New York Academy of Medicine, October 19, 1910.

Cystoscopy.—Bladder distention 200 c.c. Diffuse trabeculation. No evidence of any prostatic enlargement and the ureters normally located. Urine in 24 hours, 1200 c.c., amber, faintly cloudy, 1016 sp. gr., faint trace of albumin; 1.4 per cent. urea (16.8 Gm.) in 24 hours. Occasional hyaline casts, few leucocytes, and some erythrocytes.

Diagnosis.—The trabeculation directed our attention to the likelihood of an existing tabes. The counsel of the neurologist, Dr. I. Abrahamson, was sought on this point in question. He reports: knee-jerks present, pupils irregular but they react. Achilles reflex present. Sensations normal in legs and body. No tabes. Furthermore the complement fixation test by the Wassermann and Noguchi systems was reported negative by Dr. J. Kaliski, thus eliminating spinal syphilis.

Treatment.—An indwelling catheter was located at first for the night; following its removal during the day, the retention continued to be a feature alongside of the incontinence. Then the catheter *á demeure* was placed permanently for five days with daily washings of silver nitrate 1 : 3000 to prevent infection, up to now foreign to the viscus. Upon the removal of the catheter on the sixth day, the patient voided in small quantity with much effort.

CONCLUSION: The best explanation we had to offer in the absence of prostatic enlargement and failure to establish the existence of a nerve lesion was that the bladder suffered changes like unto the heart and kidneys in consequence of senility.

In support of such a view, the following case, by way of clinical proof, is cited: In *Lyon Medical,* March 16, 1890, Daniel Moliere [1] reports under the caption "Dysurie Senile" peculiar disturbances in the urination of the senile, which have much in common with prostatic hypertrophy, but they are encountered also in the absence of any gland involvement. He attributes the sudden onset of retention (dysuria) and increased ardor to an affection of the vesicoprostatic plexus.

In the same year, 1890, Ultzman,[2] in the series of the *Deutsche Chirurgie,* says: "In advanced age the urinary insufficiency, even if a marked paresis is not demonstrable, is

nearly always the rule. That prostatic hypertrophy peculiar to advanced age constitutes a mechanical obstacle is well established. Yet we would err greatly were we to assign all cases of senile insufficiency of the bladder to this affection. Often the cause of insufficient emptying of the bladder rests upon senile changes (atrophy of the bladder)."

Launois [3] in 1894, under the guidance of Guyon, says, that in the retention of the aged, arteriosclerosis is a factor of the first importance and the lesions of endo- and periarteritis involve not only the prostate but extend to the bladder and kidney.

In 1899 Guyon [4] gave to us his contribution on "Prostatisme Vesicale," also spoken of as "Prostatisme Senile," and above all perpetuated as "Prostatisme sans Prostate." In a clinical sense he considers that senile dysuria is dependent, not invariably on prostatic obstruction, but is a resultant of many factors which have a common cause; this should not be styled arteriosclerosis but a trouble of nutrition which may be brought on by the inroads of years or by the failure of the organism in consequence of intoxication or premature wear and tear.

At this stage it may be opportune to introduce the report of an undetermined case of senile dysuria observed with Dr. H. Goldenberg in his service and to whom I wish to make my acknowledgments for consent to report this interesting case.

G. P., No. 110,633, admitted Nov., 1909, aged fifty-five. Five weeks in medical service with pneumonia; while there, developed retention. Habit of voiding every two hours day and night for two years. Never any retention or incontinence at night until two and a half weeks ago. Since then, dribbles continuously at night. Sexual impotence for three years. No gonorrhœa or syphilis; temperate alcoholic habit; 800 c.c. urine, purulent, withdrawn.

Cystoscopy.—Fundus heavily trabeculated, few small diverticula. Mucosa injected. Trigone and ureter orifices normal, except they were so close together that they could be seen in the same field. Ureter peristalsis visible. *Absolutely no prostatic enlargement.* Sphincter margin a horizontal line. No sign

of middle lobe. Rectal sphincter relaxed. Prostate small, atrophic. Following instillation of $AgNO_3$, 1 per cent., into deep urethra, 5½ oz. of a very good stream voided. Residual urine thereafter 2 oz.

Dr. B. Sachs reported: pupils sluggish; knee-jerks present. There is a possibility that the retention is of senile origin.

Endoscopy (Goldschmidt).—Flattened colliculus. Nothing of the nature of a valve seen at the internal ostium.

Capacity Test.—350 c.c. boric solution let into the bladder; patient, while pressing on the abdomen, voids (bladder-expressibility of Zuckerkandel) 150 c.c. After injecting $AgNO_3$, 1 per cent., voids the remnant of 150 c.c. in a very good stream. Incontinence is not overflow but due to atony of the bladder detrusor or weakness of the muscular sphincter prostaticus, while in the daytime, the patient has control over his bladder by voluntary control of his sphincter externus. Urethra seven and a half inches in length and absolutely no resistance to catheter at introitus of bladder. No appreciation of 2 per cent. $AgNO_3$ in the posterior urethra. Extremes of cold and heat not complained of or differentiated. To determine whether dribbling would follow complete emptying of the bladder, this latter was done upon retiring. None the less, dribbling continued throughout the sleep, proving relaxation of the sphincter at night. Cystitis improved some; other symptoms persisted. Discharged at first with diagnosis of atrophy of prostate and senility. Subsequently asked to enter for another neurological examination. Dr. B. Sachs this time expressed himself as believing that there might be an arteriosclerosis of vessels affecting the circulation of the cord.

In 1901 Ciechanowsky,[5] by his anatomical researches, showed the influence of age on the bladder muscle. Between 40 and 50, the muscle constituted nearly three-quarters of the bladder wall, whereas amongst the aged it was hardly two-thirds or only half. And he, too, says that senile debility alone is not a question of years, that premature age can attack the bladder as well as other organs and is aided by alcoholism and other intoxications.

In the following year, 1902, Halle and Motz[6] also admit the influence of age in these cases of "prostatisme sans pros-

tate" in causing a relative atrophy of the muscular tissue; and that sclerosis and fatty degeneration of the bladder wall are secondary to infections, intoxications, etc. On the other hand, they emphasize that total atrophy is rare, and that the quantity of muscle is superior to that which exists in normal bladders, and that as in true enlargement, muscular hypertrophy is the essential lesion.

So, too, Zuckerkandel,[7] 1904, says: "Senile changes or chronic distention are capable of seriously damaging the bladder muscle in its function. There are incurable forms of retention amongst the senile, in whom no mechanical or nervous cause can be determined. Whether an atrophy or degenerative muscle is out of play is not known."

In the meantime, the removal of enlarged prostates with complete restoration of bladder function had set at naught the pronouncements of Guyon and Thompson, that the atony was irreparable.

Within the same period, Motz and Arese [8] proved, in prostatics without a prostate, that the extirpation of a gland, which at least in appearance could not form an obstruction to emission of urine, would restore function lastingly, so in persons who had been a long time afflicted with complete retention. They consequently insisted that it was not a muscular degeneration which was the primary cause of the bladder atony, and, what is significant, the bladder in such cases was no more deficient in muscle than in cases of actual hypertrophic prostate.

We, too, have experienced the complete restoration of bladder function after prostatectomy in a number of cases that proved to have small prostates at operation. One such case, however, with an unfavorable outcome is herewith narrated:

J. G., aged sixty-seven, No. 112,844, Jan., 1910. Denies gonorrhœa and syphilis. Alcoholic habit temperate, obstinate obstipation. Bilateral rupture (?). Within the last two weeks these hydroceles (ruptures?) grew larger, coinciding with which urinary frequency and ardor increased. Soon complete retention set in, necessitating catheterization for twelve days prior to admission. Great thirst.

Status Præsens.—Pale, flabby, very ill, low tension, pulse regular, no murmur, signs of emphysema. Abdomen: rigid, distended from corprostasis. Tenderness over suprapubic area in which region bladder dulness extended half way up to the umbilicus. Genitals: distention of scrotum by the two large hydroceles on either side caused disappearance of penis, and owing to tension of large amount of fluid, the testes were difficult to discern. By rectum: prostate felt, but not considered enlarged. Soft catheter enters bladder easily, 900 c.c. urine withdrawn; alkaline, 1012, purulent.

For three days catheterization was performed twice a day without any return of function, and then for one week the indwelling catheter brought no betterment. Pyuria precluded cystoscopic examination. On the eleventh day, the bladder was opened by a suprapubic incision. A trabeculated bladder felt, and a small, hard, annular prostatic enlargement felt, with very small posterior lip about one-half inch in height. Finger gripped at introitus. Another week of drainage and then a small overhanging lip was removed. It measured 1 x ¾ cm. Dr. F. Mandelbaum, pathologist, reported that the specimen was hypertrophic, not carcinomatous. At the end of six weeks, the suprapubic fistula was completely closed. The cystitis necessitated treatment, whereupon the introduction of a catheter, Nélaton F. 18, meeting with obstruction, a sound was occasionally passed. The patient was able to void 150 c.c. of $AgNO_3$ introduced into his bladder. After five months, the fistula of bladder opened again and has done so on and off eight months after operation. He has retained all of his symptoms. Residual urine 8 oz., can void 8 oz., and urine is purulent.

Cystoscopy.—Nitze enters easily. Bladder trabeculated, and near the outlet two translucent folds are to be seen.

Epicrisis.—But for the findings of the pathologist that the glandular tissue removed and examined was hypertrophic, we would as a last analysis place this case as an instance of atrophy of the prostate, to which diagnosis we are disposed by the cystoscopic findings of folds in front of the neck of the bladder which are described and pictured by English[9] in his description of atrophy of the prostate. These three cases narrated can at the best only be placed in a category of retention without mechanical obstruction.

This very topic was the order of the day at the First International Congress of Urology at Paris in 1907. On this occasion, Albarran [10] exhaustively treated this subject. His introductory remarks were to this effect: "Until recently, it was the belief that the mechanical obstruction of prostatic hypertrophy alone could not explain retention, and the onus was put on the degenerated muscle. We know now that this also has been abandoned." He then proceeded by numerous examples, experimental and above all clinical, to elaborate the theory promulgated by Janet [11] five years previously as "Inhibition Vesicale." Thus Albarran says: "When the neck is free and the prostate of small volume, one cannot quite think of a cervical urethral obstacle which could awaken the possibility of a retention, independent up to a certain point of the macroscopic form of hypertrophy. Reflex inhibition of the bladder causing retention is a part of prostatic hypertrophy and is present in all forms of prostatitis, acute or chronic." In this category he places "the cases of retention accompanying prostatitis described by Janet and Genouville (*l. c.*), and the form of prostatitis cystoparetica of Goldberg,[12] Notthaft (*l. c.*), and the chronic hypertrophic prostatitis of Albarran (*l. c.*). At times these prostatites go on to cure by fibrous transformation and then in turn the reparative process gives rise to retention without creating a veritable obstruction. Such he believes to be the case in Chetwood's "Contracture of the Neck of the Bladder," in which there is neither hyperplasia of the muscular elements of the sphincter nor of the adenomatous tissue, but rather a fibrous stenosis of the vesical orifice (most often of gonorrhœic origin), a description identical with that of Keyes, Sr.[13] Furthermore, there is neither enlargement of the prostate nor increase in length of the canal. Albarran (*l. c.*) says he himself has seen similar cases only recognized at operation. Strictures of the urethra of large calibre are known to give rise to complete or incomplete retention.

From all these facts it is necessary to conclude that in small hypertrophied prostates, hypertrophic prostatitis, and large strictures, the obstacle is insufficient to explain the retention for which one cannot make the spasm responsible when

the catheter shows it to be absent. Therefore it is necessary to admit, perhaps an inhibition of vesical contractility, perhaps the loss of the inhibitory power we possess over the external sphincter, *i.e.*, to relax it.

In conclusion Albarran (*l. c.*) adds: "We could furthermore give numerous observations of vesical retention, complete or incomplete, in patients beyond fifty years of age in whom the cause of vesical insufficiency cannot be disclosed on the aforesaid or any other ground. *They are the prostatics without prostates.* Several present a slight prostatic lesion, and one could attribute their retention to phenomena of inhibition, arising from the prostate, but in others the prostate is healthy." Then follows the recital of a case like unto the last one mentioned by us. The history is as follows:

Patient, aged sixty. Since two years difficulty of micturition increased until he came with complete retention. For six months he has been instilled. Minute examination of the urinary apparatus and of the nervous system reveals nothing abnormal. The prostate in particular is normal. No projection in the neck by cystoscopy. The patient demanded prostatectomy in spite of advisement to contrary. A suprapubic operation was performed for the removal of the prostate. Microscopic examination, healthy gland. Recovery from operation, but complete retention persists.

In 1909, Asch,[14] of Strassburg, at a medical meeting reported that he saw five males afflicted with retention, dribbling, and tenesmus, in whom no mechanical obstruction or central nerve lesion could be made out. By cystoscopy the bladder was made out to be trabeculated. These trabeculæ are due to the secondary muscular hypertrophy, following a primary degeneration of the muscle, or the degeneration is traceable to diseased nerves of the bladder or of the ganglionic centres of the bladder. A trabeculated bladder is therefore of myogenic or neurogenic origin. A second variety of trabeculated bladder is due to extension of destructive inflammatory processes, associated with scattered areas of true muscular hypertrophy. In a third class of cases with above symptoms, four males, the bladder is void of trabeculæ but incapable

of concentric contraction. These bladders, infiltrated in part, atrophic in others, have to be differentiated from carcinoma; they are likely inflammatory.

Within this year Casper,[15] 1910, reported a case of a man sixty-eight years of age, with unusually protracted retention (complete), of eight years' standing, in whom there was no urethral or vesical obstruction, and an absence of nerve lesions. He regards the case as one with degenerative bladder changes characterized by sclerosis (Guyon).

In 1909, in their recent text-book, Desnos and Minet[16] add their testimony thus: "We meet with senile individuals in whom urination is hesitating or slow at the beginning, with a diminished stream and increased frequency at night. They are impressionable to all congestions; later on they will be subject to retention and incontinence and act as veritable prostatics. They present, however, neither hypertrophy of the prostate nor any modification of the neck, but the muscle is degenerated."

CONCLUSION.

From the history of cases instanced and elucidated by the authorities cited, we must admit that a class of cases exist in which the stigma resides essentially in the muscle insufficiency, though what is the fundamental cause for this atony remains undetermined. For we have to choose from a muscle degenerated by arteriosclerosis, or sclerosed secondary to infections, or primarily atrophic following a peripheral nerve lesion, or secondarily so, as an atrophy that follows every hypertrophy. Tersely stated, the atony is of vascular, myogenic, neurogenic, or infectious origin. Finally, in some cases all these factors operate towards the same end.

It is therefore commendable in singling out cases for operation to take cognizance that these borderline cases be not subjected to operations, and that the cystoscopic examination be resorted to as a routine in aiding to determine for or against this.

There then but remains the cases of contracture of the neck of the bladder *in so far as they occur in the aged*(?). Could they be diagnosticated *by other than autoptic findings*

at the moment of opening the bladder, they would be suitable for operation along the lines laid down by Chetwood. Albarran (*l. c.*) admits encountering these cases *at operation only.*

This interesting chapter in urinary retention is *sub judice.* Consequently operations of any kind undertaken therefor can only be vindicated as being exploratory. The alternative of operation is a catheter life.

As a befitting conclusion to this essay, I cite the words of our esteemed nestor of American urology, Dr. Jno. W. Gouley[17] from his recent "Surgery of the Genito-urinary Organs:" "Vesical dilation, even when there is no obstruction to urination, is not uncommon among elderly men. Post-mortem examination of such bladders showed the absence of any mechanical obstruction."

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BONE ABSCESS TREATED WITH MOORHOF'S BONE WAX.

A REPORT OF FIVE CASES.*

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THE following report is based on five cases of chronic osteomyelitis with bone abscess treated with the iodoform bone wax advocated by Mosetig-Moorhof.[1] Moorhof,[2 3] Silbermark,[4] and others have reported such good results following the use of the wax, with shortening of the convalescence, absence of painful dressings, etc., that it should, if the report of these cases were correct, be a distinct improvement on the usual method of treatment.

The author has used the wax in two other cases more recently which are not included here, which have so far done well, although it is too early to draw any conclusions as to the end result. Moorhof advocates his wax in all chronic osteomyelitis cases with bone abscess, in tubercular bone cavities, and as an injection after the excision of a joint. It serves only as a temporary plug to replace the tissue removed and later is either absorbed or extruded. It is of no use in acute or diffuse osteomyelitis, and in the chronic cases one should wait until the acute exacerbation has subsided before applying the filling.

As a rule, the use of foreign substances to fill cavities in the body, although strongly advocated by the originator of a method, has in the hands of the general surgeon given poor results and has gradually been discarded, giving way to the older method of packing and draining.

* The author wishes to express his thanks to Dr. M. H. Richardson, Dr. S. J. Mixter, and Dr. C. A. Porter for permission to operate upon and report these cases which were admitted to their wards.

Among the many substances that have been advocated may be mentioned blood-clot, decalcified bone chips, muscle flaps by transplantation, skin flaps by plastics, and Beck's bismuth paste. Blood-clot has been used by the author with perfect success in three cases of bone cyst in which there had never been suppuration and sterilization of the cavity was unnecessary, and in two cases of long-standing osteomyelitis, in which the cavity contained only clear fluid. The main disadvantage in the use of blood-clot is that it is an ideal culture medium, but, on the other hand, it is not a foreign body and is well tolerated.

This report does not deal with the use of the wax in tuberculosis or in the soft parts, but only with bone abscess. In children these almost invariably do well under the ordinary treatment, opening and drainage, but the operation necessitates for a greater or lesser period of time packing or the insertion of a wick, which is painful, and there may be a free discharge of pus. In addition, the common history is profuse discharge for a long time and frequent painful dressings.

Moorhof's first report [1] appeared in 1903. Since then the component parts of the wax have been modified by some men, and Moorhof himself substitutes dermatol for iodoform in certain cases.

The wax is usually made as follows: equal parts of spermaceti and oil of sesame are sterilized in a water bath, and later 60 parts of this is mixed with 40 parts of iodoform. This gives a yellowish, brittle wax, melting at about 50° Centigrade. When used it is heated to just above the melting point and kept constantly stirred, or the iodoform will settle to the bottom of the flask. Care must be taken also not to overheat the mixture or the iodoform will be decomposed.

Quite a number of articles have been published reporting cases treated with the wax with, on the whole, good results. Meurer,[5] who gives a good bibliography, describes in detail 45 cases, and concludes that its use permits of a more conservative treatment of these cases and insures prompt healing. Nine of his cases were osteomyelitis, with six perfect results and three failures. Of the total number treated, 34 were

"successes" and 25 of these healed by first intention. Moorhof reports 195 cases treated with the filling, all with good results; 79 of these were osteomyelitis. The report is detailed and is accompanied by a large number of good radiographs.

Histology.—Silbermark[6] has done a series of experiments on dogs, making bone cavities, filling them with the wax, and examining them at varying lengths of time up to three weeks. As a result of these he concludes that the cavity is slowly filled with granulation tissue, later forming fibrous tissue and new bone, the wax being absorbed; but the process takes place so slowly there is little danger of iodoform poisoning. Iodine can, however, be demonstrated in the urine for some time, and cases of iodoform poisoning have been reported (Kotzenberg).[7] This observer gives the results of 11 cases operated upon by him. One of these cases was a cyst of the lower jaw, three were tubercular cavities (all healing by first intention), and eight osteomyelitis cases. Of these last, two healed by primary union, three went somewhat septic, and three had a sinus discharging only serum for some time. He considers that the success of the operation rests on the asepsis and that the sepsis in his cases was not the result of the wax.

The operation should be performed as follows, and the success depends on the attention to details and the care with which the various steps are carried out. Silbermark[4] has devised many special instruments, such as a saw attached to a dental engine, a burr, and a hot-air apparatus for drying the cavity.

The operation described below presumes the cavity to be in the tibia, and should be modified as occasion and the bone involved demands. The leg should be elevated and an Esmarch bandage and tourniquet applied to render it bloodless.

An incision, four or five inches long, curved to the inner or outer side, is made and carried down to the bone. The flap is then dissected back, with the opening of the sinus in the centre if one is present. A flap of periosteum is turned back, or this may be done with the skin flap, and the bone with the cloacæ in it exposed. The cortical bone is then removed

with a chisel or circular saw, and the cavity freely exposed, so that all parts are accessible. It is usually necessary to remove a large portion of the cortex to accomplish this, which may be difficult and tedious on account of the eburnation. The cavity when opened is usually filled with thick yellow pus and indolent granulation tissue. Every portion of the cavity should then be cleaned until firm, healthy bone is reached, curettes of varying shapes and sizes being used and later, if necessary, a burr. The object is to get it as clean and in as good condition as a dentist would a cavity in a tooth for filling. After removing all dead tissue, the cavity should be rendered sterile and dry in order that the wax may stick to the walls, and if this is done thoroughly, subsequent ooze is effectually stopped by the wax. Sterilization is best accomplished by swabbing out with 95 per cent. carbolic acid followed by alcohol. The cavity may then be douched with a 1 per cent. solution of formalin, adrenalin, or salt solution, to stop any ooze from the bone, a slight amount of which will occur in spite of the tourniquet. Drying was best accomplished in the cases reported by treating the walls of the cavity on the principle that one would use to dehydrate a microscopic specimen. It was first washed out with alcohol, then alcohol and ether, and lastly with ether. This was followed by a hot air blast, which, in the author's hands, has not been very satisfactory. The hot air apparatus used consisted of a foot pump which forced air through a coil of ⅜ in. copper tubing, which was kept red hot over a Bunsen flame. The air was filtered through cotton to remove the dust and was presumed to be sterile. To the ends of the copper tubing a piece of sterile rubber tubing having a glass nozzle was attached. This drying process is by far the most difficult step in the operation and is quite important. Once dry, the cavity is filled with the wax, which is kept constantly agitated in the flask to prevent the settling of the iodoform, the laws of gravity being observed in the process. It is usually more satisfactory to let the leg hang down while the lower portion is being filled, and as soon as the wax is partially set, to tilt it up and

fill the upper portion. The flap is then drawn over and the periosteum and skin sutured, a small gutta-percha wick being left in from 24 to 48 hours if necessary. The line of the skin incision should not be directly over the cavity in the bone. Before suturing the flap in place, all sinuses and granulating areas should be either excised or sterilized with carbolic acid and alcohol. A firm dressing is applied and the tourniquet taken off, what little bleeding there is being controlled by pressure. Dressings should be done at intervals of two or three days.

Healing in the ideal cases and in many of those reported has been by first intention, but primary union was not obtained in any of the cases herein reported. The later history has been in all a sinus that has discharged a small amount of clear serum and filling, not pus, for a varying length of time up to four months.

ABSTRACT OF CASES.

CASE I (Dec. 16, 1908).—Male, aged thirty-three. Twenty years ago kicked below the knee by a horse. The place became red, swollen, and tender, and in two months broke open, discharging pus for three months. Four years later without cause it broke again, discharging for two months. For past 15 years has caused no symptoms. Denies venereal disease.

One year ago leg again began to pain and was opened by a physician. It healed in a few weeks. One month ago the same thing happened. The incision is now healed, but the leg is painful and tender.

Physical examination unimportant, except as regards leg. Over the head of the left tibia is a red, tender, semifluctuant swelling, three inches in diameter. The bone is considerably thickened and the skin shows scars of the previous operations. Radiograph shows an indefinite cavity in the head of the tibia, surrounded by thickened cortical bone, and considerable periostitis.

December 18: Operation. Incision over head of tibia and considerable serum evacuated; no pus. Culture showed pure staphylococcus.

December 22: Esmarch bandage, tourniquet. Incision over

head of tibia carried down to bone. Periosteum thickened. Flap dissected free, and cortex removed with chisel, opening a cavity 1 x 2 inches in diameter filled with pus. Cavity cleaned with curette, gauze, etc., till all infected parts removed. Sterilized with carbolic acid, alcohol, and adrenalin (for ooze). Dried with alcohol and ether and hot air blast. Filled with wax and wound closed tight. This was done with difficulty, as the soft parts were so swollen they came together with considerable tension. Culture showed *Staphylococcus aureus.*

Subsequent History.—Convalescence was uneventful. There was considerable ooze from between the stitches, the serum containing flakes of iodoform. Eventually the wound healed by first intention, except a small sinus, which continued to discharge serum and filling for about four months. At no time was there any pus, and the patient learned to dress his leg himself with gauze. From the time the wound healed till the present date, 15 months from the time of operation, there has been no trouble.

X-rays were taken before (Fig. 1) and immediately (Fig. 2) and three months after operation, and also one year after operation (Fig. 3). They show the gradual diminution in size of the cavity and the final replacement of the wax by normal bone. The halo around the filling in Fig. 2 is the granulation tissue in the cavity which has not yet become bony.

Case II (March 10, 1909).—Male, aged fourteen years. When four years of age sores broke out on his legs, and since then has had discharging sores on the leg about once a year. Has also had sores break out over the left scapula, on the left wrist, and over the ribs on the right side at various times. Three months before entrance sore broke on right leg and has not healed.

Examination.—Scars of old wounds over left scapula, to outer side of left thigh, over the seventh rib on the right, on the inner side of right thigh just above knee, and two others over the head of the right tibia. Over lower third of right tibia, soft parts swollen, red, tender, and fluctuant. Radiograph shows a bone abscess about 4 in. above the ankle in the tibia on the right (Fig. 4).

March 13: Incision and considerable pus evacuated.

March 26: Esmarch bandage, tourniquet. Old incision and sinus excised. Considerable bare cortical bone found. Cortex removed and cavity opened. Curetted, sterilized with carbolic

FIG. 1.

Case I before operation. Abscess head of tibia. Some periosteal and marked cortical thickening which obscures the cavity in the radiograph.

FIG. 2.

Case I a few weeks after operation, showing the cavity filled with wax.

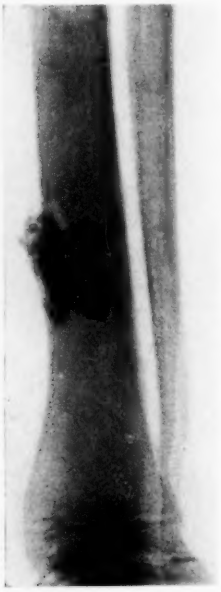
FIG. 3.

Case I one year after operation. Wax discharged or absorbed and cavity filled with normal cancellated bone.

FIG. 4.

Case II before operation. Abscess cavity shows plainly in the shaft of the tibia. There is some periostitis.

FIG. 5.



Case II after operation. The cavity filled with wax.

FIG. 6.

Case III before operation. Marked cortical and periosteal thickening. Abscess cavity seen indistinctly.

FIG. 7.

Case III some weeks after operation. The light area around the wax is granulation tissue which is replacing the filling.

acid and alcohol, dried with ether, and filled with wax. Skin flap and periosteum sutured in place with some difficulty, because of tension. Culture showed *Staphylococcus aureus.*

Recovery uneventful. Wound healed by first intention with a small sinus, which discharged serum and flakes of wax (Fig. 5). Discharged from hospital April 12, 1909.

May 5, 1910, thirteen months later, reports by letter that the leg is "all right," but the wound discharged some during the winter. The letter was very unsatisfactory, and the questions asked not answered.

CASE III (May 6, 1909).—Male, twelve years of age.

Nine months ago went to bed with "rheumatism" in the right knee, which persisted for five months. Four months ago hit his right knee, the trauma being followed by pain and swelling, and an abscess formed and broke. This has been discharging ever since.

Examination.—Opening of discharging sinus 2 in. below right knee, through which dead bone may be felt. Head of tibia thickened. Radiograph shows the knee-joint sound, considerable thickening of the cortex, with periostitis and a distinct cavity in the head of the tibia (Fig. 6).

Operation (May 13).—Esmarch bandage, tourniquet. Incisions over head of tibia and sinus excised. Periosteum dissected back and cortex removed with chisel, opening a cavity 2 x 1½ in. in diameter filled with thick pus. Curetted clean and sterilized with carbolic acid and alcohol. Dried with alcohol, ether, and hot air. Filled with wax, and skin and periosteum sutured over, there being too great tension to allow complete closure.

Culture showed *Staphylococcus aureus.*

Following the operation there were several pockets of pus in the soft parts about the knee, but the bone cavity did well.

Discharged from hospital July 3, 1909, with a small sinus discharging serum and filling (Fig. 7).

November 17: Good use of leg. Sinus closed for some time.

April 30, 1910: Wound solid. No pain. Function of knee perfect.

CASE IV (May 12, 1909).—Male, nine years of age. Three weeks ago sprained left ankle. Since then it has been swollen, red, and tender, and he has not been able to use the leg.

Examination.—Over left internal malleolus is a tender, red

swelling, evidently connected with the bone, hard, and non-fluctuating. Foot swollen. Radiograph shows an irregular cavity in the lower end of the diaphysis and a possible smaller one in the epiphysis. There is considerable periostitis.

Operation (May 19, 1909).—Esmarch bandage, tourniquet. Three-inch incisions over lower end of tibia carried to bone, and periosteum dissected back. Cortex removed with chisel, and a cavity one inch in diameter filled with thick yellow pus opened. Cleaned out, sterilized, and dried as in previous cases. Filled with wax, and periosteum sutured. Wound closed without drainage. Culture sterile.

Wound apparently healed by first intention, but three weeks after operation a sinus opened which discharged a small amount of serum and filling for about three months.

May 2, 1910: Wound solid. No interference with motion. Perfect result. X-ray taken.

CASE V (May 12, 1909).—Male, twenty-six years of age.

Nine years ago left knee became swollen and tender without known cause, and broke open, discharging pus. He was in bed nine months at this time. Since then the sore has broken open once or twice a year, discharging each time for a few weeks.

Present Attack.—Nine weeks ago the leg became painful and tender, and has confined him to bed until the present time.

Examination.—Over anterior inner aspect of left tibia a short distance above the ankle is a dull red, tender, fluctuant swelling, several inches in diameter. Radiograph shows considerable periostitis and a cavity in the bone at this point.

Operation (May 24).—Esmarch bandage, tourniquet. Incision to bone. Periosteum elevated and cortex removed with chisel, opening a cavity 1 x 2 in. in diameter filled with pus; cleaned, sterilized, and dried as in previous cases. Filled with wax, and soft parts approximated with difficulty, leaving a considerable defect in which a small wick was inserted. Culture showed *Staphylococcus aureus.*

Recovery uneventful. The sutured portion of the wound healed by first intention, and at discharge there was a small sinus discharging serum and some of the filling.

May 31, 1910: Examination shows wound solid. No pain or discomfort since operation. Motions of ankle perfect. Sinus continued to discharge before healing for about six months.

REMARKS.—An analysis of these cases shows the following results:

None healed absolutely by first intention.

The bone cavity in all of the cases was evidently rendered sterile by the cleaning process, and the wound in three, the only ones closed without drainage, healed by primary union, with the formation later of a sinus discharging serum and wax. Culture from four of these cases showed *Staphylococcus aureus,* while the other was sterile.

Case III was operated upon while there was considerable inflammation, and it would have been better to have waited until this had quieted down. Although following operation there was pocketing of pus in the soft parts, the cavity in the bone gave no trouble, the wax apparently keeping the pus out. On leaving the hospital the discharge from the sinus was of serum and filling, as in the other cases, and the end result has been good.

In Case V there was no attempt to get primary union as the tension of the soft parts was too great, but at discharge the leg was in the same condition as the other cases.

The wax in all the cases made a remarkably good dressing, obviating the necessity of changing wicks, and making the dressing easy and painless.

As to the end results, Cases I, III, and IV and V may be called perfect at the end of one year. There is no interference with the function of the limb, the wound is solid, and in Cases I and V, X-ray shows the cavity evidently filled with normal bone. There is no trace of the wax, which has been either absorbed or discharged.

What the result would have been if the abscesses had been treated in the usual way, by opening and packing, cannot be said, but it seems improbable that they would have done as well.

Case II may now be considered well, although the progress of the case was not as satisfactory, judging from the letter received, as in the others.

More or less difficulty was experienced in all of the cases

in closing the wounds, due to tension, which could have been obviated to some extent if the incisions had been made more curved and the flap, therefore, larger, although in no case was the opening into the bone made directly under that through the skin.

CONCLUSIONS.

Moorhof's iodoform plombe or bone wax is of value as a filling, in selected cases of circumscribed abscess cavities in bone.

Its use shortens the convalescence and makes the dressings easy and painless.

The success of the operation depends on painstaking care and attention to detail.

In the above cases, at least, the wax was treated by the body as a foreign substance and discharged.

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Moorhof: Surg., Gyn. and Obst., vol. iii, p. 547, 1906.
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Moore: Jour. Am. Med. Assoc., vol. xliv, p. 1582, 1905.

LACERATION OF THE AXILLARY PORTION OF THE CAPSULE OF THE SHOULDER-JOINT AS A FACTOR IN THE ETIOLOGY OF TRAUMATIC COMBINED PARALYSIS OF THE UPPER EXTREMITY.*

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We are all more or less familiar with those cases in which the upper extremity becomes partially powerless, the muscles, especially those about the shoulder, atrophied, and the shoulder and arm stiff and painful, from a trauma of the shoulder region. Among the neurologists, in particular, the tendency has been to ascribe them to a lesion of the brachial plexus, as in Erb's palsy, in which the trauma is localized to a point above the clavicle, where the nerve-fibres to the muscles usually found involved are grouped together (Erb's point). In the cases which I have in mind, scapulohumeral limitation of movement is associated, on account of which, I believe, many of them have been ascribed by surgeons, in particular, to inflammation in the subacromial or subdeltoid bursa. I have stated in detail elsewhere [1] that I do not believe they are best explained by the bursitis theory, which does not account for the loss of power, and the supporters of which admit that they have difficulty in explaining the pain frequently radiating down the arm. Codman [2] says that in some cases these secondary changes in the nerves and muscles almost amount to a real paralysis and simulate lesions of the brachial plexus or progressive muscular atrophy. Nerves may be ruptured but I believe that in most cases they are not. The basic lesion, in my opinion, is a more or less extensive laceration of the axillary portion of the capsule of the shoulder-joint, the lesion of an anterior dislocation of the shoulder.[1] The essential cause of the dislocation is forced abduction of the arm, the most free and least restricted move-

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ment in this joint, and the movement most frequently exposed to severe violence and to the leverage of a fully extended and rigid upper extremity, as in falls on the hand. The chief resistance at the shoulder to movement beyond the physiological limit due to forced abduction is from the axillary portion of the capsule, which frequently tears in consequence. Often from such a force an anterior dislocation of the shoulder results, in many of which, as the arm immediately afterwards drops to the side of the body, spontaneous reduction takes place and the fact of the occurrence of the dislocation is never recognized. In probably a great many more, the tear in the capsule is not sufficient to permit a dislocation, and it then represents the lesion of a sprain, a condition which at the present time is practically never recognized as such. The lesion is deep seated and difficult to locate by the ordinary signs of a sprain. The patient does not recall that forced abduction was a factor in the causation of the symptoms, because of the excitement of the moment, and because immediately afterward the arm fell to the side of the body into the position of rest, of most complete relaxation of the torn portion of capsule and therefore of least pain, where he finds it when he begins to take account of what has happened.

Internal rotation further relaxes the injured portion of capsule, so that the patient soon learns to keep the forearm in front of the chest in the sling position. Abduction and external rotation, especially the former, drag upon the seat of trouble and are avoided so long, that when the pain subsides and the patient wishes to use the limb, he finds that he cannot move it far from the side, the torn portion of capsule having become contracted in its relaxed condition. The loss of power and the atrophy of the muscles of the shoulder and arm are due primarily, I believe, to the involvement of the nerves in the axilla by perineuritis and neuritis from the inflammatory conditions in the axilla, which are secondary to the lesions in and about the joint. The atrophy and loss of power are probably in part due to the resulting scapulohumeral limitation of movement, and I have thought that it was in part due to the limitation of movement per se, *i.e.*, that there resulted a certain loss of balance in the functions of the muscles of the extremity

because some of those at the shoulder were thrown out of action by the shortened capsule. This was suggested by an observation in one case, in which a considerable impairment of the movements of the hand disappeared on the day on which the scapulohumeral limitation of movement was broken under an anæsthetic and the arm dressed in full abduction. The patient was delighted to find that so quickly all of the movements and much of the power had returned to this hand. Nothing else had been done than to tear the shortened capsule that could explain the return of power in the hand, so that I could see no other explanation than that the scapulohumeral ankylosis alone had been in some way responsible for the weakened movements in the hand and perhaps for some of that in the forearm and arm.

I am not prepared to enter into a detailed discussion of an intricate and confused neurological question, but I have been impressed with an apparent similarity between these stiff and painful shoulders and some of those which are called, by the neurologists in particular, traumatic brachial paralyses; and I wish to offer a few facts which tend to show why they are often confused with each other. The surgeon is usually impressed most by the disturbances in the shoulder-joint, the neurologist by the loss of power in the muscles. The latter rarely takes into account the scapulohumeral ankylosis, occasionally referring to it vaguely as secondary to the condition of the nerves and muscles, that is, to contractures of muscles and ligaments.

Schulz [3] made an interesting study of the late results in cases of dislocation of the shoulder which appeared in Küttner's clinic at Breslau during a period of five years. There were 160 cases, but a large number failed to return for reexamination, and some of the remainder were excluded because of the complications which existed. The late results in 54 uncomplicated (by any fracture, according to the X-ray, by myositis ossificans, or nerve paralysis) traumatic dislocations did not justify the prevailing tendency to give a favorable prognosis after reduction of a dislocation of the shoulder. In only seven cases (13 per cent.) were there no disturbances of motion in the arm, no noteworthy diminution of strength,

and no pain in bad weather. In 14 cases (26 per cent.) the movement was free, but the power in the arm was reduced at least a third, in most a half, and in one two-thirds. In 39 cases (75 per cent.) there was weakness in the arm, and in about a half of these there was more or less continual pain in the shoulder, which was so much worse in bad weather that it became necessary to suspend work. In many cases movements absolutely necessary for many occupations could not be performed at all or only to a slight extent. Schulz says that the chief cause of these poor results is to be sought in the cicatricial contraction of the joint capsule and surrounding tissues.

Delbet [4] and Cauchoix in a recent study account for what seems to me to be very much the same type of disturbances following dislocations of the shoulder, by assuming the existence of injuries to the nerves. They say that at first it was universally admitted that these nerve lesions were due to the wounding of the terminal trunks of the brachial plexus by the luxated humeral head, but that at the present time this conception is much combated, because the muscle groups paralyzed correspond not to the territory of innervation of a nerve but to that of a root. They consider it unnecessary to dispute all the theories which have been offered to explain how these paralyses are produced. It appears to me that we have, in these various theories referred to, an indication of the obscurity of the etiology of the loss of power frequently associated with dislocations of the shoulder. Delbet and Cauchoix consider that most authorities at the present time accept the theory of a radicular paralysis in most of the cases due to a trauma about the shoulder; and they divide the cases into those due to lesions of the roots of the plexus or radicular paralyses, those due to lesions of the plexus itself, and those due to lesions of the terminal branches of the plexus. The chief object of their work was to encourage early operation. In three cases they exposed the nerves in the axilla and freed them of adhesions. When the plexus or its roots are the seat of the lesion they advise a similar operation above the clavicle. Vandenbossche,[5] in discussing traumatic radicular paralyses due to injuries about the shoulder, says that because of the multiplicity of the

nerve lesions, their association with truncular lesions, and the fugaciousness of certain symptoms, the diagnosis of these paralyses is difficult to make, except at the beginning. He also favors operation in grave cases.

That the radicular and plexus lesions are considered as frequently being due to injuries of the shoulders other than dislocations is attested by the already extensive literature on the subject. Underlying all this discussion and confusion, and in my opinion accounting for it, is the difficulty in locating a nerve lesion, which can explain the great variety of the nerve manifestations presenting themselves in these cases. Originally, as stated by Delbet and Cauchoix, the tendency was to locate the lesion in the axilla, that is, that it was due to the trauma produced by the dislocated humeral head. This became untenable, because the distribution of the nervous disturbances was too extensive and varied to be accounted for by such isolated nerve lesions as could be expected from such a cause. In the search for a higher nerve lesion, the condition of the joint is generally ignored. I suspect that scapulohumeral limitation of movement is nearly always present in these cases diagnosed as traumatic brachial paralyses, and if the various nerve symptoms which occur could be accounted for on the basis of the conditions existing in the axilla, a long step would be taken in the direction of clearing up the pathology. I have already shown that a sprain of the shoulder is probably common to those cases due to a wide variety of accidents to the shoulder region, and I have pointed out that the pathology of a sprain due to forced abduction at the shoulder is essentially the same as that of a dislocation of this joint.[1] The tear in the axillary portion of the capsule occurs in all, but is most extensive in the dislocation which may be regarded as the type. Hemorrhage must occur in every case and will vary with the number and size of the blood-vessels opened. Some of the large lymph trunks which are numerous here may also be torn. The extensive opening into the joint is in the most dependent portion, so that the extravasated synovial fluid, blood, and lymph fall by gravity into the loose tissue of the axilla, which has been more or less displaced and lacer-

ated in luxations by the head of the humerus. Ewald[6] believes that traumatic myositis ossificans always occurs in muscles about joints, and is due to the effect of the escaping synovial fluid which infiltrates itself among the muscle-fibres. If this were true, the synovial fluid is capable of inducing a high degree of irritation. The presence of the blood, lymph, and synovial fluid in the axilla, where they surround and infiltrate the various branches of the brachial plexus, and the inflammatory reaction induced by their presence and the associated trauma can account for a marked degree of perineuritis and neuritis in some or all of the nerves in the axilla. According to the number of nerves thus involved and the degree of involvement, we may have a large variety of nervous manifestations, and we need not assume the existence of a direct trauma to the terminal branches of the brachial plexus, the plexus itself, or its roots to account for them. The evidence which I have examined, to my mind, does not seem to indicate that actual nerve rupture in dislocations is especially common. The most frequently ruptured nerve is evidently the circumflex, but I believe that in many of the cases in which the diagnosis is made of a paralysis of the deltoid from a rupture of the circumflex nerve, the nerve is not so much injured as inflamed or bound in cicatricial tissue. I believe also that the marked atrophy of the deltoid seen in these cases is the result, not so often of a complete or a partial rupture of this nerve as of the compression of the nerve by the extravasation and the associated neuritis and perineuritis, of the consequent adhesion, and of the scapulohumeral limitation of movement, which throws the deltoid out of action more than any other muscle because it is the great abductor of the arm.

Delbet and Cauchoix collected from the literature 33 cases in which symptoms of paralysis of the muscles of the upper extremity followed dislocations of the shoulder, and added two of their own, with another case in which the paralytic condition followed a fracture of the surgical neck of the humerus. The evidence obtained from them, as these writers interpret it, pointed to traumatic lesions of the nerves; and in so far as it was demonstrated by operation and postmortem, it showed

involvement of the nerves in the axilla in most cases. In my opinion, these cases can be best explained by the changes produced in the nerves by the inflammatory reaction induced by the extravasated blood, lymph, and synovial fluid, and the trauma of the neighboring tissues.

The autopsy in the case of Th. Anger, performed seven days after the accident, revealed a bloody extravasation of the circumflex nerve to an extent of 2 cm., at the site of the capsular tear and extending into the terminal branches of this nerve. (The circumflex nerve passes backward between the subscapularis and latissimus dorsi muscles, and for a short distance lies directly on the capsule in the immediate vicinity of the tear, so that it is particularly exposed to the exciting causes of inflammation already referred to.) Bardenheuer in operations found intraneurilemmatic effusions, which he thought were produced at the time of the rupture of the surrounding blood- and lymph-vessels. The condition of the nerves was distinctly inflammatory, and he considered it sufficient to cause the conductility of the nerves to disappear by the compression which the inflammation exercised on the nerves. Nicaise found the circumflex nerve swollen, between the inferior borders of the subscapularis and teres minor muscles (the nerve here lies directly on the capsule), and the nerve was enclosed in a sheath of inflamed cellular tissue. The histological examination showed an intense perineuritis. In another case Nicaise found the circumflex nerve bound in dense cellular tissue, in front of the capsule. Panas found a roughening of the circumflex nerve. Vincent determined clinically a paralysis of the median and ulnar nerves, and the case coming to autopsy, he discovered these two nerves surrounded by a zone of thickened fibrous tissue separating the luxated humeral head from the second rib. Müller found a complete disappearance of the axillary fat, which was replaced by resisting connective tissue. It was difficult to follow the nerves toward the summit of the axilla on account of their adhesions. In Wallis's case the terminal trunks of the brachial plexus were adherent to the periosteum of the humerus just below the surgical neck. Delbet and Cauchoix met with similar conditions in their own three cases.

There is little in these findings to show an actual rupture of the involved nerves, but much to indicate that they had been enveloped in a zone of inflammation due to the lesions in the surrounding structures produced by the dislocations. I believe we may fairly assume that the nerve lesions in those cases of paralysis from trauma about the shoulder, without dislocation, are of a similar character. That actual nerve rupture is not the rule in these cases, as I have seen them, is suggested by the fact that these paralyses tend toward recovery. Either with the assistance of the physician or without it, persistent efforts are usually made to increase the movement in the joint, and this tends to lengthen the contracted tissues, to favor absorption of the inflammatory tissue, and to loosen adhesions, all of which favor a return of the nerves and muscles toward the normal. Many of them, however, fall far short of reaching the normal. Prolonged rest favors a more dense and persistent contraction of the tissues and a more permanent atrophy of the muscles and loss of power. There is a variety of these cases, in which the humeral head falls appreciably below the acromion process, leaving a distinct depression between the two. The joint becomes flail-like, the arm practically helpless, and to a less extent the forearm and hand. This condition is very serious, I believe permanent and sometimes progressive, although my experience with it has not been extensive enough to warrant a positive expression of opinion. I have purposely avoided discussing it here because it deserves more attention than I can give it now.

The following is the only case in which I have had the opportunity of observing the patient from the day of the accident. It presents a few features which are particularly interesting and instructive.

A colored man, fifty-six years old, on June 26, 1910, was found unconscious in the subway, where he was employed as a laborer, and in an unconscious and delirious condition he was brought to the University Hospital, where he was admitted to the service of Professor J. William White, to whom I am indebted for the privilege of reporting the case. Examination showed a cut over the right eye, a contusion on the back of the head, and subcon-

junctival ecchymosis of the right eye. The pupils were equal and reacted to light, and there was no bleeding from the nose or ears. On the following day on account of his delirium and outcries he was placed in a side room, and because of the violence with which he threw himself about, he was strapped down by the wrists and ankles. In going over the matter later with the interne and the attending nurse, both were positive as to the violence with which he threw about his two arms, and both were satisfied that there could have been no loss of power in them at that time. My own recollection of the patient's actions during my visits, and the fact that he had been strapped down by the wrists confirmed these statements. On the third day the unconsciousness had cleared slightly, and it was observed that he could not raise his left arm or forearm from the bed and that he had very little power in that hand. On the following day there was slight improvement in power in the hand and forearm, but he could not move his arm. On passive abduction at the shoulder after the arm passed a right angle, the patient, who was conscious enough by this time to appreciate it, complained of pain in the axilla and resisted the movement. There was also marked tenderness on pressure in the axilla. On full abduction there was observed a considerable but well-outlined swelling about on a level with the shoulder-joint. It suggested a hæmatoma. Although the mental condition improved very much, there was little change in the condition of the left upper extremity. On July 2, a neurological examination was made by Dr. J. W. McConnell, and the following facts noted: No disturbance of the pupils or of the sphincters. Patient complains of a sensation as if the left hand, forearm, and arm were asleep. The muscles of the whole extremity are extremely weak. Those of the right can be well performed except abduction, which when performed actively or passively, seems to cause considerable pain referred to the shoulder-joint. The same condition obtains on the left side with, additionally, when the abduction is almost completed, a distinct swelling which appears just behind the pectoral border. This swelling is soft and not to be found on the right side under similar circumstances.

Individual movements can be made as follows: Extension, flexion, and abduction of the fingers of the left hand performed, but much less well than on the right side. Extension and flexion of the hand at the wrist-joint are less well performed than on

the right, but better than the movements of the fingers. Pronation on the left side better performed than supination, but both movements better than on the right side. Flexion of the forearm gives distinct contraction of the biceps. Distinct contraction of the supinator longus but much less power than would be expected from such a contraction. Same is true of extension on this, the left side. Voluntary abduction of arm very slight. Attempt at adduction causes distinct movement of adductor muscles but very little movement of arm. Passive rotation of arm on its long axis is fairly well performed, and the excursion is quite as large as in the right arm. Electrical examination shows prompt galvanic response in normal series. There is an area of hypalgesia in left hand, including an area on the ulnar side of the dorsum of the hand up to the styloid process of the ulna and extending over to and including the third metacarpal (middle finger); also over the dorsal surface of the little finger and dorso-ulnar surface of the palm to the median line and fissure in palm, indicating the metacarpophalangeal articulations. Reflexes normal.

I had not observed any trouble with the right shoulder and arm until Dr. McConnell discovered it, nor did I know that the left was involved until the interne, Dr. Sprowl, called my attention to the weakness in the hand and forearm. I concluded that I was dealing with a bilateral tear of the axillary portion of the shoulder capsule. I endeavored to prevent contraction of the capsule by forcing once daily each arm into full abduction. Against the complaints of the patient I persisted in this effort for about two weeks, but the resistance and pain gradually increased and I concluded to give it up. The right shoulder now gave him most trouble, and the resistance was more marked than on the left side. Hoping to prevent further contraction of the capsule on this side, I fixed the shoulder by a plaster cast, with the arm at slightly less than a right angle. The cast was removed nine days later. The scapulohumeral limitation of movement and loss of power in the arm were more marked than on the left side, on which the loss of power below in the hand and forearm was much more evident.

August 1: The patient had been receiving for several days in the orthopædic gymnasium massage and passive movements, but he now insisted on going home, which he was permitted to do. Although he promised to return for further treatment, he failed to do so.

That the paralysis in this case was not due, primarily, to a traumatic lesion of the brachial plexus, is shown by the fact that for about 48 hours the arms were moving about vigorously, and straps at the wrists were required to restrain them. The first evidence of loss of power was detected on the third day in the left extremity, that in the right arm not until about a week had passed. That the lesions which caused all the trouble were in the axillæ of both sides was clearly evident from the severe pain there on abduction of the arms and the associated scapulo-humeral limitation of movement. The localized swelling in the left axilla suggesting a hæmatoma gradually disappeared and was no longer evident when the patient left the hospital. It indicated strongly that its location directly under the shoulder-joint was due to a tear of the axillary portion of the capsule and consisted of a collection of blood from torn vessels, possibly also of lymph and synovial fluid. The pressure of the extravasated material and inflammation about the nerves will account for the gradual development of the nerve symptoms, which appeared earlier on the side on which the extravasation was most marked. The whole clinical picture, to my mind, is one that can be accounted for only by an extensive tear of the axillary portion of the capsule on each side.

In connection with this case I would again call attention to Schulz's observations. Of the 160 dislocations of the shoulder, he studied only the 54 uncomplicated cases, *i.e.*, uncomplicated at the time of the dislocation and the reduction by any nerve paralysis. Therefore, the evidence of involvement of the nerves which developed later can be accounted for only by assuming that it was the result of, and secondary to, the joint condition, as in my case. Schulz so concluded.

Another similar condition, the pathology of which has never been satisfactorily explained, is the infantile obstetrical paralysis, or brachial birth palsy. Duchenne[7] was one of the first to call attention to it. Unfortunately I have not been able to gain access to his contribution on this subject and the following is a translation of his conclusions by H. M. Thomas:[8] "Certain violent obstetrical measures, which may be necessary during the difficult lowering of the arm after

the body of the infant has been born, or the strong traction on the shoulder by a finger introduced in the shape of a hook in the axilla, after the head has been born, may at times produce a paralysis of the arm, localized in the deltoid, infraspinatus, and flexors of the forearm, and characterized by the falling of the arm close to the side of the body, the rotation of the arm inwards, and extension of the forearm on the arm. The prognosis of this paralysis is, in general, grave; it may be cured by local faradization, but if this is abandoned, it becomes incurable and produces atrophy of the member." Erb calls attention to the similarity between these cases and those in which the brachial plexus is injured in adults, and believes that they are due to pressure at Erb's point, situated 2 to 3 cm. above the clavicle and somewhat outwards from the posterior border of the sternocleidomastoid and just in front of the transverse process of the sixth cervical vertebra. Stimulation at this point produces a simultaneous contraction of the deltoid, biceps, brachialis anticus, and supinator longus (apparently usually also of the infraspinatus and subscapularis). Thomas says that, why such varying conditions as are known to produce the paralysis should always make pressure at this point, was not explained. Carter was the first to advance the theory that in the great majority of cases stretching of the upper roots of the brachial plexus, and not pressure on the plexus, was the cause of the paralysis. The latter view seems to be the generally accepted one at the present time. Schoemaker [9] collected 95 cases from the literature, and of these, 55 were head presentations and 40 breech. Without going into such a general discussion as the question deserves, I wish merely to call attention to a few facts, which will, I believe, justify the suggestion that a tear in the axillary portion of the capsule of the shoulder-joint may be the explanation of the condition found in many of these cases. Pressure at Erb's point has never been established as the cause. Stretching of the upper roots of the brachial plexus, with laceration, ought to produce more frequently a more complete and permanent paralysis than is exhibited in these cases. There is a difference of opinion as to the permanency of the paralysis, but most authorities

consider that the majority of cases tend to recover more or less completely. The most positive evidence that I have found in favor of stretching of the roots of the plexus is that offered by Clark, Taylor, and Prout.[10] It would seem, at first thought, that their evidence could not be controverted, yet it does not seem that operation for these cases is being generally adopted. Apparently the prime object of their work was to show that many or most of these cases could be cured only by operation. In seven cases seen within a period of two years, they excised portions of the involved roots and sutured the ends together. In one case the rupture involved the entire plexus. Five of the remaining six showed the maximum damage above the junction of the fifth and sixth cervical roots, and one below it. In one, the fifth root was found torn across, and the ends separated about 1 cm. and bound down by connective tissue. In one case the fifth root was torn across just below the junction, and the distal end displaced inward and downward about 2.5 cm. to the front of the scalenus anticus, where it was adherent. They do not refer to any cases not operated on, and one is in doubt as to whether they operated on all their cases. If they did, then they evidently regard the prognosis as more unfavorable than most authorities. In the discussion which followed the reading of Walton's paper,[11] before the American Neurological Association, it was developed that no neurologist present, except Lezynsky, had ever seen an obstetrical birth palsy in an adult. Lezynsky saw one at twenty years and another at seventeen years, in one of which there had been a dislocation at birth. He saw another case in a child in which there had also been a dislocation at birth. According to the conception of the pathology entertained by Clark, Taylor, and Prout, the usual result of traction is to produce a tear in the perineural sheath, with a resulting small hemorrhage into and beneath the sheath and infiltrating the strands of nerve-fibres and the meshes of the epineurium. In all their operative cases they found the deep cervical fascia invariably thickened, especially over the plexus. An extravasation of blood, lymph, and synovial fluid, 4 or 5 inches upward under the clavicle, from an injured shoulder-joint, with the infant in the recum-

bent position, would more satisfactorily explain the thickening of the cervical fascia and the cicatricial tissue about the nerve-roots, than would a small tear in the perineural sheath or a rupture of one or two nerve-roots. If the continuity of a nerve-root was broken by traction, the divided ends would probably fall together again as soon as the traction was removed, when we would have a more perfect approximation than could be obtained by the most perfect suturing after the excision of a portion of the root. The cicatricial band of union between the ruptured ends might be difficult to locate and recognize months or years later, in an adherent mass of tissue. The question might fairly be raised as to how a separation of 2.5 cm. between the ends of the divided root is to be explained. In amputations we retrench the nerve-ends, because they do not tend to retract, and if not so treated are likely to become caught in the surrounding scar tissue. There is not enough movement of the surrounding structures to account for so much separation, and the contraction of the cicatricial tissue between the nerve-ends should draw them together. I should regard the theory that traction on the upper roots of the brachial plexus as the cause of these birth palsies is not yet established.

In a head presentation, when the head is born the next step is to deliver one arm, which then occupies a position of abduction. If the scapula did not move with the arm, this would be nearly the normal limit of abduction. Abduction beyond a right angle is permitted by movement of the scapula, which is produced by tension on the corresponding muscles, and particularly on the axillary portion of the capsule. Traction on this arm to aid the delivery of the rest of the body must apply a dangerous force to the tense axillary portion of the delicate, infantile capsule. H. M. Thomas reports three cases.

The first was seen six weeks after birth. It was a head presentation and forceps delivery. The right arm was born first and traction was made on it. Paralysis of this arm was noticed soon after birth. In the second case, seen eight days after birth, the labor was normal up to the delivery of the head. The delivery of the shoulders was difficult. The anterior (left) shoulder was engaged under the symphysis and was delivered only after considerable difficulty. The head was depressed until this

shoulder slipped under the symphysis and was delivered, when by elevating the head (thus forcing the left arm into extreme abduction), the other shoulder was delivered without much trouble. The left arm was paralyzed. It was observed of this case that the shoulder could not be abducted nor the arm rotated outward. In the third case, after a difficult forceps delivery of the head, the shoulders became fixed, and traction was made on the head flexed toward the right shoulder (evidently to deliver the left arm, which must have been forced further into abduction in the delivery of the opposite arm). It was the left arm that was paralyzed. In none of the three were the reactions of degeneration found.

I have referred to these cases because they present some evidence to show that forced abduction was employed in just the arm which was afterward found paralyzed. The most characteristic feature in cases due to a tear of the axillary portion of the shoulder-joint capsule is the scapulohumeral ankylosis, although, as already shown, it can easily be overlooked. If it were present in all birth palsies it would point very strongly to a capsule lesion as the cause of this condition. It cannot be accounted for on the basis of a rupture of the roots of the plexus. It was clearly present in Thomas's second case, it might have been in the others. Schoemaker reported two cases of his own. In one the affected arm was in marked internal rotation, and when it was raised and let go, it fell back. It is not stated that there was or was not resistance to abduction. In his second case, there was marked scapulohumeral ankylosis, almost complete. Duchenne called attention to the internal rotation of the arm, and it was present in all three of Thomas's cases. It is explained on the basis of the paralysis of the external rotators of the humerus. The theory of a torn axillary portion of the capsule will explain it. Abduction and external rotation drag upon the lacerated capsule and thus produce pain in the early stages. Therefore, the arm is held in the position of rest, adduction, and internal rotation. Later from cicatricial contraction the ankylosis tends to become permanent. The results of treatment in Thomas's cases are suggestive of a capsule rather than a nerve lesion. He employed passive motion, massage, and the galvanic current. The first patient was found dead in bed with its mother three weeks after treatment was begun. In the second case (in ten weeks) and in the third (time not given), the child was prac-

tically well when the treatment was abandoned. The treatment was begun early, and in ten weeks the passive motion could have stretched the recent cicatricial tissue easily, and with the massage could have aided materially in the absorption of the reparative new tissue and adhesions of the nerves, the condition of which was probably improved by the electricity. An injury to the roots of the brachial plexus would probably not have recovered so quickly.

Guillemot [12] reports a remarkable series of 12 cases, observed between the ages of fourteen and twenty-five years. The histories showed that all had been delivered either by podalic version or by the breech, and by the same midwife. In 7 cases both arms were paralyzed and in 5, only one arm. Internal rotation was noted in 15 arms, and in 4 it was not observed. Scapulohumeral ankylosis was positive in 13 shoulders, slight in 1, and probably present in the remainder, judging from the associated statements. The paralysis was observed within a few days after birth in all but 2, and in connection with these no statement was made showing when it was first noted. In many of the cases there were associated joint lesions in the shoulders, elbows, and wrists, proving conclusively, says Guillemot, that strong traction must have been made on the arms in delivery. That the condition of the arms was not due to myelitis, was indicated by the fact that in all, the patellar reflexes were normal and in none was there any weakness in the lower extremities. Sensation was better preserved than motion, and in several cases in which the paralysis was almost total, there was neither anæsthesia nor analgesia. In 11 cases the history pointed to a breech presentation. It will be recalled that of Schoemaker's 95 cases, 55 were head presentations and 40 breech, although for all labors the former are relatively much more common than the latter. The evident relationship between breech presentations and birth palsies has been explained upon the basis of the traction on the after-coming head, and consequently upon the cervical roots of the brachial plexus. It has been shown that the palsy frequently occurs when the birth has taken place without traction on the head. In a breech presentation, when the body is

delivered the arms are forced into extreme abduction alongside of the after-coming head, and any turning of the body to one side or the other to assist in the delivery of one arm throws that arm into still more marked abduction. The danger to the capsule is then extreme, so that skill and care would be required to avoid its rupture. The associated joint lesions of the shoulders, elbows, and wrists proved conclusively that strong traction was made on the arms in delivery, as Guillemot said, not on the head.

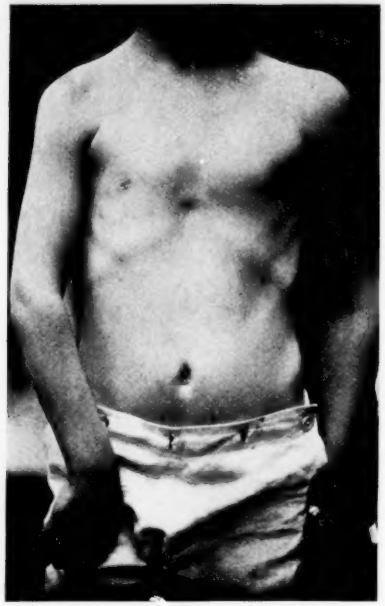
The main point that I have tried to make is that the pathology underlying many of these brachial birth palsies is that of a dislocation of the shoulder, or its analogous condition, a sprain. The paper of Schulz and that of Delbet and Cauchoix emphasize the importance of the dislocation, in similar cases not occurring immediately after birth. I believe that a careful search of the literature would show that it bears an equally important relation to the birth palsies. Lewis [13] reported a case, which had been diagnosed as a birth palsy and in which a posterior dislocation was recognized and reduced. The patient recovered full use of the arm. Young [14] reported a similar case and directed attention to the frequency with which dislocation of the shoulder is mistaken for birth palsy. He adds that if the dislocation is allowed to continue it will produce a pressure palsy resembling a birth palsy.

Through the kindness of Dr. R. H. McCombs, registrar of the Children's Hospital of Philadelphia, I was enabled to trace a case of brachial birth palsy, which had appeared at the dispensary of this institution, July 18, 1906, when three years of age, on account of an inguinal hernia. It was noted in the history that the patient had a birth palsy of the right arm. He never returned to the dispensary. He is now seven years old. From the mother I learned that instruments had been employed at birth, and that the left humerus and the right clavicle had been fractured, showing that strong traction had probably been made on the arms in delivery. On the following day the right arm was observed to hang helpless at the side. At two months of age, he was taken to a nervous dispensary of another hospital, where the attending physicians are particularly competent to recognize a

birth palsy. The visits were not continued long, as the child was too young. At eight months, he was taken back to the same hospital, and again received electrical treatment, which seemed to indicate that a diagnosis of birth palsy had been made, but the mother was never told what was wrong with the arm. When I found him, recently, the arm was hanging at the side, rotated internally, and considerably shorter than the opposite arm (see Figs. 1 and 2). He had regained considerable power, and could abduct the arm to an angle of about 140 degrees. The limitation was due chiefly to a mechanical obstruction at the shoulder, but for which he could probably have raised his arm in full abduction. There was a well-marked wrist-drop and an evident atrophy of the deltoid. Dr. J. W. McConnell, by electrical examination, found a paralysis of the musculospiral nerve. The parents had never been told by any one that the child had a dislocation of the shoulder. Upon inspection the picture was that of a brachial birth palsy, but after palpating the shoulder carefully because of a peculiarity in its shape, I detected a subacromial dislocation. The humeral head could be pushed forward, evidently into the glenoid cavity, but not as far forward as normally. It would not stay in this position if the pressure was removed, and could not easily be held there when the boy abducted or adducted his arm. It seemed to be more easily fixed in the normal position when the arm was in abduction. The patient's brother, now about twenty-five years of age, insisted that he had observed from the birth of the patient that the shoulder was out of place.

On October 28, 1910, he was admitted to the service of Professor J. William White, in the University Hospital, and on the following day I operated on him. The incision was made along the posterior border of the deltoid, which was retracted upward. The tendon of the infraspinatus muscle was divided transversely, the capsule exposed, and the joint opened. The glenoid surface had not the normal cup shape, but was rather convex, with a tendency to slope backward, favoring the slipping posteriorly of the humeral head into the dislocated position. The head was placed in its normal position and the arm held at a right angle with the body while the capsule was shortened to hold the head in this position. The infraspinatus tendon was repaired by suture, and the wound closed without drainage. After the dressings were applied the arm was fixed in nearly full abduction by a light plaster cast, and an opening left through which the

FIG. 1.



Subacromial dislocation of right shoulder, with paralysis of musculospiral nerve. Anterior view. The wrist-drop, shortening of limb, and internal rotation of arm are shown. There is an abnormal prominence at the site of the old fracture of the clavicle.

FIG. 2.

A

Posterior view. *A*, abnormal prominence produced by dislocated humeral head. Position of hand shows internal rotation of arm.

wound could be exposed. Healing occurred by first intention and the skin sutures were removed on the seventh day. On about the twelfth day the patient developed symptoms of scarlet fever and was removed to the Municipal Hospital. The cast was there removed two weeks after operation. In about a week the arm could be brought to the side of the body, and the patient was permitted to use it as he lay in bed. On September 2, I saw him at the Municipal Hospital, and then observed that the dislocation was recurring, the tendency of the humeral head being to force its way back to the dislocated position, probably on account of the abnormal shape of the glenoid cup. There was evident at this time a marked improvement in the muscles supplied by the musculospiral nerve, as shown by the disappearance of the wrist-drop. When both arms were held out from the body, the hand on the affected side was held in exactly the same position as on the sound side, *i.e.*, with the palms facing downwards, both hands were in dorsal flexion at the wrist and on the affected side was held in this position without any apparent difficulty. I believe that this degree of improvement in the musculospiral nerve, during the few weeks in which the humeral head was kept in the normal position and the nerve thus probably relieved of abnormal pressure, proves that if the humeral head can be kept in its normal place the arm will become much stronger and a very useful member.

We have here another case like those of Lewis and of Young, in which a posterior dislocation of the shoulder occurring at birth was mistaken for a birth palsy. The clinical picture of birth palsy was present in all three. They show, I believe, that there is a close etiological relationship between the two conditions.

Similar palsies in the adult, from trauma about the shoulder, are due in the great majority of cases, I believe, to tears of the axillary portion of the capsule. While probably true, this is not so clear in the accidents of birth involving the upper extremity. Forced abduction tends to produce an anterior dislocation, but that occurring at birth is almost always posterior. Forced abduction tears the axillary portion of the capsule, but what is the relation between this and a posterior dislocation which must tear the posterior portion also? The following explanation may have some value. There is one im-

portant difference in the forced abduction applied to the infant's arm at birth and that applied to the arm in the usual accidents in adults. In the adult the limb is used for defense and is placed or employed by the patient himself, according to the nature of the accident. In the infant at birth, the limb is used as an aid in delivery and is controlled by a second person. In a fall on the hand, which is probably the most frequent cause of dislocations of the shoulder in adults, we have, in addition to the forced abduction, a push in the long axis of the limb in the direction of the shoulder. At birth, assuming that traction on the arm is the cause of the dislocation, we have, in addition to the forced abduction, a pull in the long axis of the limb, away from the shoulder, a force directly the opposite to that sustained in a fall on the hand which produces an anterior dislocation. Since the long axis of the glenoid cavity is oblique from above downward, a strong pull on the fully abducted arm should tend to produce an upward and backward dislocation.

The three cases I have referred to would seem to indicate that a posterior dislocation of the shoulder in the new-born is usually associated with a palsy. If the same condition developed in the absence of a dislocation it would probably be called a birth palsy. Why not in the presence of a dislocation? Stimson says that paralytic dislocations of the shoulder are particularly frequent in the new-born, and that Duchenne saw eight of this kind in ten years. Panas quotes Duchenne as saying that before his attention was attracted to this complication, he had overlooked it in other cases. According to Panas, Duchenne called attention to the fact that there was diminution of electrical contractility and atrophy of the muscles supplied by the musculospiral and ulnar nerves in these cases. As already stated, I have failed to obtain access to Duchenne's contribution on this subject. In my opinion, there is room for question as to whether all of these dislocations are paralytic, *i.e.*, that the dislocations are the result of associated paralysis. I believe that in my case it was not, but that the paralysis was the result of the dislocation. The reduction of the dislocation in the case of Lewis and in that of Young was followed by a disappearance of the paralysis. In my case the dislocation has existed so long that more or less permanent changes may have

taken place in the nerves and muscles, and a return to the normal may be impossible. The prompt improvement following operation, however, is very encouraging. I believe, however, that if the dislocation had been recognized at birth or soon afterwards and had then been reduced, a complete cure would probably have followed. The only positive nerve paralysis at the present time, after the dislocation has existed seven years, is in the musculospiral. Could the dislocation be responsible for this isolated paralysis? The course of this nerve and its relation to the humerus is peculiar to it. In the lower part of the axilla, it begins to pass backward, and then passes obliquely around the upper half of the humerus close to the bone. The backward dislocation of the upper end of the humerus forces the nerve backward with it and must exert an abnormal compression on it, the seven years' existence of which might be responsible for the present condition of the nerve and the muscles it supplies. The results of operation in this case would seem to support this view. Those cases in which there is a depression between the acromion and the humeral head, the joint flail, and the muscles paralytic, are relatively common soon after birth, but as already stated I expect to take up this subject in another paper, so that I shall avoid its discussion now.

Believing as I do, that in tears of the axillary portion of the shoulder capsule we have a hitherto unrecognized cause of many nervous disturbances in the upper extremity, the pathology of which has been in doubt, I feel justified in suggesting a possible relationship between this injury and some of the craft palsies. In a previous paper[1] I reported a case of stiff and painful shoulder with loss of power in the arm, in which diagnoses of neuritis and of osteo-arthritis were made. The patient is a well-educated man, who was disposed to investigate and to interpret, so far as possible, the meaning and cause of the symptoms of his condition. He was first in the hands of a physician for some months, who was anxious to discover the underlying cause of the trouble, and I had examined the arm for the first time; yet none of us had suspected the existence of the marked scapulohumeral ankylosis, the gradual elimination of which was followed by a disappearance of all the

troublesome symptoms. In connection with this case we might consider the one previously mentioned, in which the palsied hand movements returned almost to the normal, so far as freedom of movement was concerned, immediately after the tearing of the contracted portion of the shoulder capsule. If in the second case, as in the first, the trouble in the shoulder had not been recognized, and the patient had been a clerk whose livelihood depended upon the use of his hand in writing, I can imagine the weakness in the hand attracting most attention. I have already reported a case, in which both shoulders were stiff and painful from rheumatism, and in which in one arm a diagnosis of writer's cramp was first made, then of neuritis of the arm by another physician, and of dislocation of the shoulder by a third physician, which was probably the cause of the aggravated condition in that arm. Turner and Stewart [15] say that in some cases the pain is occasionally severe, and affects the upper arm and shoulder as well as the forearm and wrist. They also say that examples of occupation neurosis are seen in men who undergo repeatedly muscular efforts, as blacksmiths, in whom the upper arm and shoulder muscles, especially the triceps and deltoid, are implicated. Poore [16] says that he recalls cases of writer's cramp in which excessive efforts with a crow-bar, pulling hard upon a rope on board ship, wringing of clothes, and severe traction on one arm while getting off an omnibus in motion were each followed by an inability to perform delicate acts. In the discussion which followed the reading of a paper by Poore [17] on writer's cramp, Godlee referred to a case which had a clicking in the shoulder and a good deal of pain, apparently muscular. The shoulder was supposed to be diseased, as the result of an injury, but Godlee could not make it out as diseased. It would seem, therefore, that many of the craft palsies are distinctly traumatic in origin. It will be recalled that in many of Schulz's cases, which followed dislocations of the shoulder, movements absolutely necessary for many occupations could not be performed at all or only to a slight extent. It is not necessary that the scapulohumeral ankylosis be marked, to be associated with severe pain and weakness in the arm as I have seen in

one case. The blood, lymph, and synovial fluid, which extravasated about the large nerve-trunks soon after the original accident, may have induced sufficient adhesions about them to interfere with their functions, and therefore with the functions of the muscles they supply; or as already stated, the weakness in the extremity, including the hand, may be due to the limitation of motion at the shoulder. Erb says of these cases that electrical examination, as a rule, shows no noteworthy changes, and that we are still very much in the dark with regard to their real nature.

The following case, seen recently with Dr. R. S. Dorsett, is very suggestive. The patient, a trained nurse, was thrown violently in a street car collision, striking, she says, against her right shoulder. In consequence she suffered severe pain in various parts of the body, but particularly in her left arm, left leg, and in the back between the scapulæ. I saw her for the first time 26 days after the accident. She then had considerable tenderness on pressure between the scapulæ, and since the accident had suffered from pain and numbness in the left upper extremity from the shoulder to the hand, where it involved the three fingers on the ulnar side. An important part of her work is the giving of massage and her chief complaint at the present time is that the loss of power in the left hand interferes with her ability to perform the massage movements. She is very much worried also because, from time to time quite unconsciously, she drops objects from her hand, such as a drinking glass, recognizing the fact only when the crash of the fallen object is heard. In order to establish or exclude a tear of the axillary portion of the capsule, the first symptom I looked for was scapulohumeral limitation of movement, and I found that full movement at this joint could be performed, actively as well as passively. It was not until a week later, on her second visit, that it occurred to me to ask if there had been any pain on movement in the shoulder, and she then stated that she had had much trouble in this respect, but that she had persisted constantly since the accident in forcing the painful and limited abduction. It was only for a few days before her first visit to me that she had been able to perform the full movement. I diagnosed a slight tear of the capsule on the left side, with the possibility of a similar but still milder lesion on the right side. The tenderness between the scapulæ was over

the back muscles, which would most resist the associated movements of the scapulæ in forced abduction at the shoulder, which I believe occurred in the original accident. There was more acute tenderness in the left axilla directly under the joint than anywhere else in the body, and I thought that there was still a slight trace of ecchymosis in this axilla, more than three weeks after the accident. About six weeks after the last visit she returned and complained that she could not voluntarily abduct the arm beyond a right angle. On account of pain in the shoulder she had neglected to continue the forced exercises, and the recurrence of the scapulohumeral limitation was the result. The pain and numbness down the arm and forearm to the hand, and the loss of power in the hand, could be satisfactorily explained by a perineuritis and neuritis of some of the branches of the brachial plexus, particularly of the ulnar nerve, due to inclusion in the inflammatory area adjacent to a tear in the axillary portion of the shoulder capsule.

The important fact here is that, four weeks after the accident, when there was little or nothing to suggest a nerve lesion in the axilla, the palsy of the hand should be so marked as to seriously impair her ability to follow her usual occupation, and to cause her to drop such light objects as a drinking glass. There is no doubt in my mind that the weakness in the hand was due to the shoulder-joint lesion, and it seems to me that the case might be classed with the craft palsies. The patient did not associate the hand weakness with the shoulder condition, but regarded it as one of a number of isolated effects of the accident, among which are the pain in the leg, in the back, about the shoulder, and the pain and numbness in the arm and forearm.

Concerning the treatment of these cases, I would place the emphasis first on overcoming the scapulohumeral limitation of movement by suitable exercises and massage, the condition of the nerves and muscles at the same time being improved by electrical stimulation. I would prefer to delay the final determination of the presence or absence of an actual rupture of nerve-fibres and the localization of such a lesion until the movements of the shoulder-joint were normal and the effects of compression or adhesions of nerves had been eliminated.

The early recognition of a joint lesion and the associated axillary inflammation is of the greatest importance, but it is likely that the majority of the cases will continue to escape recognition until the conditions become chronic. I have gone over the treatment more fully elsewhere [19] and will now only briefly review it.

In the acute stage, the severity of the pain on movement may demand immobilization of the shoulder-joint. This is done preferably with the arm in full abduction, to prevent contraction of the torn capsule during the healing process, which should be complete in two weeks. This position is awkward, uncomfortable, and difficult to maintain, but the result is well worth the trouble it involves. The Monk splint modified by Codman [2] is a good one for the purpose. A light plaster cast, including the upper part of the chest and arm to the elbow, will permit more complete abduction, more complete rest of the joint, and will not require as much care as the splint. If there has been a dislocation of the shoulder, it will probably be safest to bind the arm at the side, for three weeks, although I believe that a recurrence could be prevented with proper support by adhesive plaster and a splint which would hold the arm at a right angle with the body. The studies of Schulz show, in my opinion, that the fear of a recurrent dislocation is chiefly responsible for the frequent long-continued stiffness of the shoulder-joint and loss of power in the extremity. I believe that we should balance the one danger against the other, and that with due precautions we can largely eliminate both. At the end of two weeks' immobilization, when there has been no dislocation, the arm should be gradually brought to the side of the body, after which massage and passive movements should be employed to bring about an absorption of the inflammatory material in the axilla, the release of any adhesions which the nerves and other structures have contracted, and thus the return of motion in the joint and of power in the muscles. Electrical stimulation will aid in the more rapid return of the nerves and muscles to the normal.

If the patient is young, strong, and ambitious, the awkwardness of the fixation of the arm in the abducted position may be avoided by permitting him to keep the arm at the side,

but with the understanding that forcible exercises are to be employed as soon as the pain will permit and before contraction of the cicatricial tissue sets in. Most cases are first recognized as a serious condition in the chronic stage, when the cicatricial tissue in the axilla is firmly contracted and very resistant. Persistent and long-continued massage and forced movements may gradually stretch the contracted capsule to its normal length, but this will take such a long time that most patients will become discouraged and give up the treatment before it has accomplished the desired result. The breaking up of the resistance under an anæsthetic at one sitting, and the employment of measures to prevent a recontraction of the torn tissues have been very successful in the hands of a few men. Küster [18] found it necessary to repeat the breaking up process frequently in some cases, but this was evidently because he dressed the arm at the side of the body afterwards and permitted the recontraction of the capsule, which could then, however, be stretched more easily because the inflammatory material was more recent and yielding than before the manipulations had been carried out. Küster regarded some very old cases as intractable. I have used this treatment in four cases with very satisfactory results and have not found it necessary to anæsthetize the patient the second time, and I believe that the method will be successful, however old the condition may be. The same efforts as in the acute stage must be made to maintain abduction or to overcome any recontraction, because what we accomplish by the forced manipulations is to produce essentially the same conditions as existed immediately after the original accident.

There are some cases in which the chief complaints are of pain radiating down the arm and loss of power, and in which the movement of the shoulder is so free as to cause a slight scapulohumeral limitation of movement to be overlooked. These are particularly likely to pass for cases of neuritis. In one case of this kind I was satisfied that there was slight abnormal movement of the scapula on passive abduction, and that a contracted axillary portion of the capsule with associated adhesions of the neighboring nerves was responsible for the trouble, which had persisted for eight months and had pre-

vented the patient from following his usual occupation, that of a machinist. Under an anæsthetic I forced the arm into full abduction at the shoulder, with the usual tearing sensation, fixed it in abduction on a splint for a few days, and afterwards forced it twice daily into full abduction. Massage was employed daily, and in six weeks he had obtained nearly full motion, much improvement in power, and was able to return to work at his trade. The slightly contracted capsule was in all probability responsible for most of his trouble. It has not been convenient to employ electricity in some of my cases, but where I have used it there has seemed to be a more rapid return of power in the weakened muscles. Whenever there is, in the muscles, an impairment of irritability to the electric current, its advantages are obvious.

In connection with the brachial obstetrical palsies, I have had only small experience, but I have been impressed with the idea that care is necessary in differentiating the various cases. I am convinced that subacromial dislocations frequently coexist and are overlooked, and that they are probably birth palsies as much as those in which there are no dislocations. I believe that the dislocation had not been recognized in my case before I saw it. The prompt improvement in the condition of the paralyzed muscles after the imperfect result of the operation proves, I believe, that if the humeral head can be kept in its normal position without impairment of the movement of the joint, the condition of the muscles and nerves will return almost to normal. If the dislocation had been reduced soon after birth, when the glenoid cavity had its normal conformation, in all probability it would have remained in place, and, after a longer or shorter period of " paralytic " symptoms such as probably follow all dislocations and vary according to the degree of involvement of the neighboring nerves by the surrounding inflammation and the effects of later adhesions and compression, the arm would have gradually returned to its normal condition. I would interpret the existence of a scapulohumeral ankylosis in a case of infantile obstetrical palsy to mean that the cause of the paralysis was below the clavicle, not above it. The treatment in such cases should aim at improving the motion of the joint, and in this way releasing the

adjacent nerves from the effects of the adhesions and compression which interfere with their function. Electrical stimulation and massage are important in improving the condition of the arm. If after the normal joint motion has been obtained and a reasonable period has been allowed for recovery of the nerves, the paralysis is still of such a character as to justify the diagnosis of a permanent paralysis of one or more nerves below or above the clavicle, the advisability of an operation to free the nerves of their adhesions or to excise a portion and suture the divided ends together may be considered.

CONCLUSIONS.

Extensive laceration of the axillary portion of the capsule of the shoulder always occurs in anterior dislocations of this joint, which represent practically half of all the dislocations of the body. Probably, while the arm is in forced abduction, many others occur, which are spontaneously reduced as the arm falls by gravity to the side of the body immediately after the accident, and the fact of their occurrence is never recognized. Just as the milder lesion, the sprain, is more common at the ankle and wrist than the fracture, which results from a similar but more severe force, so, in all probability, are the sprains at the shoulder more common than the dislocations. We can thus account for a large number of cases in which the same capsule tear occurs.

The extravasation of blood, lymph, and synovial fluid, resulting from such a lesion, falls by gravity into the loose tissues of the axilla, where they surround and infiltrate some or all of the branches of the brachial plexus, giving rise to a non-infectious inflammation, which adds to the already existing compression of the nerves and induces a perineuritis and neuritis. The interference with the function of the nerves caused by these conditions can account for the multiplicity of the nerve symptoms and the fugaciousness of certain symptoms, so that one need not assume the existence of a traumatic lesion of the brachial plexus, its roots, or its branches, to account for them. The post-mortem and operative findings in Delbet and Cauchoix's cases, and the clinical findings in Schulz's cases, support this pathogenesis.

The infantile obstetrical palsies, in which one or both upper extremities are involved, may be the result of a similar axillary condition. This implies that forced abduction of the arm, with or without traction on it and not traction on the head, is the important causal factor. Dislocations at birth give rise to similar palsies, and in these capsule tears undoubtedly occur. The palsies associated with these dislocations are probably completely curable by the recognition and reduction of the dislocations soon after birth.

We may have in unrecognized capsule tears the pathological explanation of many craft palsies. In this connection they at least deserve further consideration.

In traumatic brachial paralyses in adults, in infantile obstetrical, and in craft palsies, the shoulder-joint should be examined for a traumatic lesion, and if evidence of it is discovered, such as a scapulohumeral limitation of movement, the first therapeutic efforts should be directed towards obtaining a return of normal motion in the joint. Operations on the brachial plexus, its roots, or its branches should be deferred until a paralysis from inclusion of the nerves in cicatricial tissue has been eliminated.

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DISINFECTION OF THE SKIN BY TINCTURE OF IODINE.*

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IODINE in various forms has been employed in surgical practice for many years, and its value as a skin disinfectant has always been appreciated by some surgeons. An Austrian colleague tells me that he has resorted to it for fifteen years.

Its special usefulness as a skin disinfectant was brought to my attention by the article of Grossich in the *Zentralblatt für Chirurgie,* 1908, page 1289. Many others were doubtless influenced by this contribution, as the more general use of iodine seems to date from its appearance.

Grossich emphasized particularly the value of the tincture of iodine as an immediate disinfectant in emergency wounds, especially of the soiled extremities of the laboring class, with whom the usual prolonged and repeated procedures for the mechanical removal of dirt were out of the question.

I began to use the method tentatively in selected cases, and finally in October, 1909, adopted it as the routine method of sterilization of the skin, both in hospital and private practice. The year's trial finds me thoroughly satisfied with it, and I believe it is better than any of our former methods for the following reasons:

The results are fully as good and probably better than with any other means of sterilization of the skin familiar to me.

Its greater efficiency in emergency cases.

Its absolute simplicity—saving time, labor, and expense for ante-operation dressings.

The avoidance of discomfort and psychical disturbance to

* Read at the meeting of the New York Surgical Society, Dec. 14, 1910.

the patient in abolishing the trying and oftentimes terrifying "preparation."

The suppression of the painful and dangerous dermatitis frequently provoked by soap poultices and antiseptic solutions.

The drawbacks are: theoretically blistering and desquamation may follow, but if the method is applied as I describe it, these are reduced to a negligible minimum.

The method which I have established in my service at St. Luke's Hospital is as follows, a variation existing between deliberately planned operations and the more urgent: When time allows the patient should be shaved *the day before* operation in the ordinary manner with soap lather, which is then washed off. The usual rule in hospital practice of giving a patient a full bath if his condition permits need not be modified, provided always it is a day *before* operation.

After the shaving *nothing* more happens till the patient has been placed on the operating table the next day and primary anæsthesia has been obtained. (It should be emphasized that the patient is on the operating table and *not* on a stretcher or couch, involving handling and disarrangement of the operative field in the transfer to the table.) The anæsthesia should also be sufficient to allow the patient to be easily maintained in the proper position. The surface to be sterilized, *e.g.*, the whole abdomen, no matter where it is proposed to incise, is exposed and *one coat* of the official tincture of iodine is applied with any suitable material, such as a gauze "wipe." Paint brushes or other means which are used on several patients are to be avoided.

The iodine should be allowed to dry spontaneously; as much as five minutes may be required, the greater degree of dryness obtaining the less easily the iodine will be removed by subsequent handling. The area so treated must remain fully uncovered during the drying, and the attempts of the nurses to encroach on it with their application of towels and "drapery" must be discouraged.

When well dry, the surface not necessary for the actual operating space is suitably covered with dry towels.

At the end of the operation another quite light coat is applied to the immediate proximity of the incision. On very delicate skins this step will be wisely omitted.

Second Method.—For the class of cases whose operation is scheduled to take place immediately, that is, within less than twenty-four (approximately) hours' preparation, no water or watery solutions must come in contact with the area to be iodinized, and shaving, if any, must be done *dry*. It has been found by experiment and observation that the swelling of the superficial layers of the skin by imbibition of water prevented the penetration of the tincture of iodine. Grossich's experience is very illuminating: with dirty areas and no washing, primary union; ordinarily clean surfaces, plus washing, frequent failure of aseptic healing.

The method I have just described may seem so ridiculously simple that wonder will be probably expressed that it should be stated with such prolixity. Experience has shown that in hospital practice it is extraordinarily hard to replace complex or traditional methods by simpler ones. It took months to overcome the ingenuity and wiles of house staff and nurses, who would persist in using some part of the discarded procedures or try to introduce modifications based on some fantastic theory of improvement.

I note also in visiting other institutions that the methods of applying the iodine vary a good deal. Recently I saw it applied as a third coat on the operating table, the intervals of application being of some hours.

One operator tells me he has stopped using iodine because it prevents his judging of the tension produced by tying of the skin sutures.

In the year ending October 1, 1910, in my service at St. Luke's Hospital, the iodine has been used as just described in all of the thousand and odd operations where disinfection of the skin is feasible, but exception is made of the scalp, scrotum, and perineum, as so far I have judged it prudent not to risk the more severe irritations likely to occur in these regions.

The results have been uniformly good. About the only infections occurred in some salpingitis cases with large abscesses; these have always given us some trouble with the wound healing.

I think the best comparison of the merits of these methods of disinfection must be in the general activity of the service. I have only a small number of beds which are constantly in demand; this last year's list of operations is the heaviest I have ever had, and could not possibly have been obtained unless we constantly had had successful and prompt wound healing.

DRY IODINE CATGUT.

A FURTHER CONTRIBUTION UPON THE SUBJECT, WITH AN IMPROVED METHOD OF PREPARATION.

BY ALEXIS V. MOSCHCOWITZ, M.D.,

OF NEW YORK,

Visiting Surgeon Har Moriah Hospital; Adjunct Attending Surgeon Mount Sinai Hospital.

In a previous communication [1] I recommended a modification of the Claudius catgut, whereby the gut is used dry instead of wet. For over six years this catgut has been in constant use by nearly all the surgeons connected with Mount Sinai Hospital, and has amply demonstrated that it possesses all the necessary qualifications of an ideal ligature and suture material. Unfortunately, about a year ago, the source of supply of our raw material went out of existence, and the catgut prepared from material from other firms, though better to look at and considerably more expensive, was soon found to be deficient in tensile strength. The other qualities of dry gut were, however, so satisfactory that we were loath to give up the use of iodine catgut entirely, and I therefore set myself the task to devise, if possible, a method which would render the poorer qualities of the raw material as serviceable as the original.

It seemed to me that the only ingredient in the original solution of Claudius which could cause a loss in tensile strength of the catgut was the water. Recognizing the tanning and preservative powers of alcohol, I determined to substitute this fluid instead of the water in the immersion fluid. After immersing catgut, therefore, in various alcoholic iodine solutions for different periods, and allowing the catgut to dry, I tested the tensile strength and found that at the end of six months it was not impaired, if anything, particularly the smaller sizes (Nos. 1 and 2), increased.

[1] Annals of Surgery, Sept., 1905.

Before using it clinically, it was manifestly essential to show that the catgut was sterile. For this purpose I carried out the following bacteriological tests, at the bacteriological laboratory of Mount Sinai Hospital:

Series 1.—I prepared a quantity of catgut in the following manner: Catgut of the sizes known in commerce as Nos. 0, 1, and 2 was rolled on glass spools and placed into 5 per cent. and 2½ per cent. alcoholic solutions of iodine. From these solutions the catgut was removed at one-day intervals, allowed to dry, and labelled No. 0, 1, or 2—5 per cent. or 2½ per cent.—1-, 2-, 3-, 4-, or 5-day catgut respectively.

Dec. 2, 1909, pieces of the catgut prepared by the above method, about one inch in length, were inoculated into tubes of bouillon, and placed in the thermostat. Daily observations were taken for eight days, and the following results obtained:

	Dec. 3.	Dec. 4.	Dec. 5.	Dec. 6.	Dec. 7.	Dec. 8.	Dec. 9.	Dec. 10.
No. 0[1], 5 per cent,[2] 1 day[3]	—[4]	—	—	—	—	—	—	—
No. 1, 5 per cent, 1 day	—	—	—	—	—	—	—	—
No. 2, 5 per cent, 1 day	—	—	—	—	—	—	—	—
No. 0, 2½ per cent, 1 day	—	—	—	—	—	—	—	—
No. 1, 2½ per cent, 1 day	—	—	+[5]	+	+	+	+	+
No. 2, 2½ per cent. 1 day	—	—	—	—	—	—	—	—
No. 0, 5 per cent, 2 days	—	—	—	—	—	—	—	—
No. 1, 5 per cent. 2 days	—	—	—	—	—	—	—	—
No. 2, 5 per cent, 2 days	—	—	—	—	—	—	—	—
No. 0, 2½ per cent, 2 days	—	—	—	+	+	+	+	+
No. 1, 2½ per cent, 2 days	—	—	—	—	—	—	—	—
No. 2, 2½ per cent, 2 days	—	+	+	+	+	+	+	+
No. 0, 5 per cent, 3 days	—	—	—	—	—	—	—	—
No. 1, 5 per cent, 3 days	—	—	—	—	—	—	—	—
No. 2, 5 per cent, 3 days	—	—	—	—	—	—	—	—
No. 0, 2½ per cent, 3 days	—	—	+	+	+	+	+	+
No. 1, 2½ per cent, 3 days	—	—	—	—	—	—	—	—
No. 2, 2½ per cent, 3 days	—	+	+	+	+	+	+	+
No. 0, 5 per cent, 4 days	—	—	—	—	—	—	—	—
No. 1, 5 per cent, 4 days	—	—	—	—	—	—	—	—
No. 2, 5 per cent, 4 days	—	—	—	—	—	—	—	—
No. 0, 2½ per cent, 4 days	—	—	—	—	—	—	—	—
No. 1, 2½ per cent, 4 days	—	—	—	—	—	—	—	—
No. 2, 2½ per cent, 4 days	—	—	—	—	+	+	+	+
No. 0, 5 per cent, 5 days	—	—	—	—	—	—	—	—
No. 1, 5 per cent, 5 days	—	—	—	—	—	—	—	—
No. 2, 5 per cent, 5 days	—	—	—	—	—	—	—	—
No. 0, 2½ per cent, 5 days	—	+	+	+	+	+	+	+
No. 1, 2½ per cent, 5 days	—	—	+	+	+	+	+	+
No. 2, 2½ per cent, 5 days	—	—	+	+	+	+	+	+

[1] Refers to the size of the catgut.
[2] Refers to the strength of the iodine sol.
[3] Refers to the number of days of immersion.
[4] — denotes no growth.
[5] + denotes growth.

In view of the fact that all the experiments made with the 5 per cent. iodine gave a negative result, even after an immersion of only one day, while some of the experiments made with the 2½ per cent. iodine gave a

positive result, we have adopted for the preparation of the catgut a 5 per cent. alcoholic solution of iodine, and all subsequent experiments were made with that only.

Series 2.—Nutrient agar was poured into Petri dishes, and after solidification parallel streaks were made upon it with the following bacteria: *Bacillus subtilis, Staphylococcus aureus, S. albus, Bacillus coli, B. pyocyaneus, Streptococcus* and *Bacillus anthracis.* Upon these I placed irregularly three pieces of iodine catgut, approximately one inch in length, and kept in the thermostat. On the following days myriads of colonies developed, but none anywhere near the catgut. The space devoid of colonies was very large, much larger than the space around the aqueous iodine catgut. A further very interesting fact to be noted in these experiments and in Series 3 was, that the bluish-green color of the pyocyaneus dish became diffused into the clear area around the catgut, but no colonies developed.

Series 3.—Tubes of agar were liquefied and infected with *Bacillus subtilis, Staphylococcus aureus, S. albus, Bacillus coli, B. pyocyaneus, Streptococcus* and *Bacillus anthracis* and poured into Petri dishes. After solidification pieces of iodine catgut were placed upon it, and then put into the thermostat. Again myriads of colonies developed, but only at great distance from the catgut. In other respects the observations noted for Series 2 apply here also.

Series 4.—In order to show that the iodine contained in the catgut did more than merely temporarily inhibit the development of the bacteria, but also effectively destroyed them, a liberal piece of the agar at some distance, one-quarter to one-half inch, from the catgut in Series 2 and 3 was removed and implanted into bouillon, and also streaked on agar. The result was sterile in every instance, except in the pyocyaneus from Series 2, where evidently I was too far from the catgut.

Series 5.—To further prove that the iodine does more than inhibit the development but actually kills all bacterial growth, pieces of iodine catgut were placed into large quantities of sterile water, which was changed on four successive days and kept in the thermostat, and finally inoculated into bouillon. No growth followed in any instance.

This is also proven by the fact, that all our experiments were carried out in the thermostat for a number of days, and yet no growth developed, though it is a well-known fact that the heat of the thermostat alone would be sufficient to dissipate the iodine content in that time.

Series 6.—Pieces of Nos. 0, 1, and 2 catgut were placed into freshly prepared 48 hour-old bouillon cultures of *Staphylococcus albus, S. aureus, Streptococcus, Bacillus pyocyaneus, B. coli, B. subtilis,* and *B. anthracis,* and all placed for another 48 hours in the thermostat. At the end of that time the pieces of catgut were all markedly swollen and softened. They were then removed and placed for five days into a 5 per cent. alcoholic solution of iodine, then dried, and kept in sterile containers. In other words, catgut was purposely strongly infected with actively growing bacteria, and then sterilized with iodine. For the sake of recognition and simplicity this catgut received the name "Catgut X," and was utilized for the following experiments, repeatedly done:

Pieces of Catgut X in all sizes and of the seven varieties of bacteria before enumerated were placed in bouillon into the thermostat and observed for a number of days. In one set of experiments, one of the coli tubes showed a growth; in another set one of the anthrax tubes showed a growth; in a third and fourth set all were sterile. As I could recover from none of the infected tubes, by cultural methods, the original bacterium, I am forced to the conclusion that they were accidental contaminations, as is likely to occur when working with so large a number of tubes.

But the most surprising and in many respects the most convincing fact occurred in this series of experiments. I found, namely, in some of the tubes quite a heavy deposit. This deposit did not look and did not act like a growth, as by no amount of transplantation into various media was I ever able to get a fresh growth. By staining, however, I found, particularly beautifully in the spore-forming *Bacillus subtilis* and anthrax, that this deposit consisted of the bacteria of original implantation. This was very interesting, because it proved to me how effectually so large a number of bacteria were killed by the method of preparation.

This series of experiments was completed in December, 1909. My faith in the iodine sterilization was such that I did not hesitate to put it at once to the clinical test, and both Dr. Gerster and myself have continued to use it since that time with perfect satisfaction. From time to time, we run across a brittle spool, but this is so exceptional that there is no doubt but that particular strand of catgut is of a markedly inferior quality. This, however, occurs, and has occurred, with catgut prepared by any other method.

A word or two about the other physical properties of this catgut. It is of a dark reddish-brown, almost black color, and has to a marked degree the characteristic odor of iodine. It is rather stiff and wiry; we have become accustomed during the past six years to a dry catgut, and far prefer it to the smooth and slippery catguts in general use; those that prefer a softer catgut may immerse it in sterile water just before using it. It knots very firmly, and the knots do not tend to unravel like wet catgut.

Finally as to the preparation. Ordinary catgut, just as it is bought from the dealers (we give preference to the dark unbleached varieties) is wound onto the well-known glass spools, in a single layer, and fastened at both ends, so as to prevent

unravelling. It is then placed for five days into a 5 per cent. alcoholic solution of iodine in a tightly closed vessel (museum jar). On removal it is spread out on a sterile towel, covered by another sterile towel to facilitate drying, and is finally kept in a sterile container.

As is seen, this method is simplicity itself, requiring no expert help for its preparation. It is certainly very cheap, an item of no small importance, particularly in large hospitals, where large amounts are used. It is to be especially noted that of late we have used a catgut, the price of which was exceedingly low, compared with some on the market.

Finally I can only again emphasize the conclusions I arrived at in the publication already quoted.

"I believe that our clinical experience, and the experimental work related, fully justify the following conclusions:

"1. The dry iodine catgut is absolutely sterile.

"2. It is impossible to infect it by ordinary means.

"3. Its imbibition with iodine is not sufficient to act as an irritant upon the tissues.

"4. Its tensile strength is superior to catgut prepared by other methods. (I have purposely kept a number of spools from the lot first prepared, now over six months, and find its strength absolutely unimpaired.)

"5. It is easily and cheaply prepared.

"6. It is absorbed only after it has served the purposes for which it was intended."

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, held October 3, 1910.

The President, Dr. Robert G. Le Conte, in the Chair.

OSTEOMYELITIS OF THE SACRO-ILIAC ARTICULATION.

Dr. James K. Young reported the history of a youth, aged 17 years, with good family history and without pulmonary or other inherited disease, who was admitted to the service of Dr. David Riesman at the Philadelphia Polyclinic, with the statement that the day after Christmas he fell while playing and injured his hip; two weeks later he had another fall, injuring his left hip, and five days previous to admission he had another fall from a wagon. Upon admission he complained of pain in the region of the left hip, and there were tenderness, heat, and deep fluctuation in this area. The leg could be moved without much difficulty. His condition not improving and a leucocyte count of 14,600 being found, the sacro-iliac joint was exposed, a portion of the ilium was removed, and the hip-joint was exposed, but no pus was found. Within six hours, however, suppuration became profuse and continued for several days. The cultures showed *Staphylococcus aureus.* His recovery was interrupted by an attack of orchitis. The case is reported on account of the rarity of acute suppurative conditions of this articulation and their recovery under treatment.

EARLY (TREVES) OPERATION FOR PSOAS ABSCESS.

Dr. Young also reported the history of a boy, aged seven years, family history negative for tuberculosis or other inherited disease, who, two days before admission to the Polyclinic Hospital, began to bend forward on the right side and to complain of pain in the right hip, with night-cries. Upon admission the right thigh was flexed, the movements of the right hip-joint

were otherwise normal. There was tenderness in the right lumbar region with rigidity of the spine, but without any fulness in the iliac region. The osseous lesion of the spine was revealed by an X-ray, and the diagnosis of psoas abscess was made. The abscess was opened by posterior dissection after the method of Treves, six days after admission. In three days the temperature was normal and in twelve days from time of operation the wound was healed and the patient was discharged from the hospital wearing a fixation apparatus.

SACRAL LAMINECTOMY FOR TUBERCULAR MONOPLEGIA.

Dr. Young also reported the history of a man, aged 38 years, who was admitted to the Polyclinic Hospital under the service of Dr. David Riesman suffering from an atrophy and pressure palsy of the left leg. He stated that several years before he had been injured by a horse. There was prominence of the spinous processes of the sacrum, with tenderness over this region. A laminectomy was performed, removing the second and third laminæ and exposing the nerves. An examination of this bone showed the presence of bony tuberculosis. The wound was an oval flap incision with the convexity upward in order to diminish infection, and primary union was secured. The operation removed the pain in this region, but pain in the lower extremity was not entirely relieved.

LACERATION OF THE AXILLARY PORTION OF THE CAPSULE OF THE SHOULDER-JOINT AS A FACTOR IN THE ETIOLOGY OF TRAUMATIC COMBINED PARALYSIS OF THE UPPER EXTREMITY.

Dr. T. Turner Thomas read a paper with the above title, for which see page 77.

Dr. James K. Young said that where children have had a palsy of the upper extremity due to subglenoid dislocation of the head of the humerus, this condition is usually mistaken for nerve palsy, but he had frequently discovered the condition to be due to a dislocation at birth, which had persisted. In one case seen by him, in a very small child, the examination was not very satisfactory, but it was shown to be a subglenoid dislocation. In some cases there has been complete restoration of function, in others but partial restoration. After reduction of the shoulder

there is often difficulty with the elbow-joint for some anatomical reason, so that sometimes he had had to also reduce the elbow-joint after reducing the shoulder-joint.

He had performed other operations of this character on three occasions. He had opened the capsule posteriorly and shortened it, making it smaller laterally. This is an original operation, and is not difficult either anteriorly or posteriorly. The capsule is opened by longitudinal incision and a portion removed or folded in and sutured together. The suturing of the capsule is important to maintain the position of the shoulder-joint. He had also removed the tendency to dislocation by division of the contracted muscles. After reduction and shortening of the capsule, the head of the bone should lie in good position without much force. It should remain in position after reduction, and there should be no pulling on the muscles or ligaments, all being so free that the joint remains in position without their aid.

Dr. T. Turner Thomas presented the boy with paralysis of the arm developing at birth, referred to in his paper. He found an overlooked subacromial dislocation of the shoulder, which he reduced by operation. In this case when he got his finger inside the joint, the glenoid surface was felt to be abnormal. That is, it was more or less convex, with an inclination from the anterior toward the posterior edge, tending to favor the sliding out of the head from its normal position. Yet this was not very marked. He wanted to see what a shortening of the capsule would do. In the two months since the operation, the dislocation has been recurring. The point had impressed him that the head ought to lie in place easily and it should not be necessary to depend upon the soft tissues to hold it in afterwards. In this case, however, it tended to force itself out, although it is not now out as far as previously by a good deal. He now proposes, if he can obtain permission, to do what a German surgeon, Hildebrand, did in two recurring dislocations of the shoulder, in which the anterior portion of the glenoid process was absent. The head tended to slide out of the socket anteriorly, so he chiselled away the posterior margin until he made a new socket with a raised anterior margin. Dr. Thomas would try to go in through the axilla and make a new socket in this case, so that the head would stay in place without pressure

upon the ligaments. The striking improvement in the condition of the musculospiral nerve in the short time in which the head was kept in its normal place, leads to the hope that if the head can be kept in place permanently, the boy will obtain a much more useful arm than he has at present.

DR. ASTLEY P. C. ASHHURST reported the following cases from the services of Drs. G. G. Davis and C. H. Frazier, in the Episcopal Hospital.

I. APPENDICITIS COMPLICATED BY SUBPHRENIC ABSCESS.

Lucy G., age 31 years, negro, admitted to Dr. Frazier's service in the Episcopal Hospital, Dec. 28, 1907. During the night of Dec. 26–27 the patient awoke with epigastric pain, which later centred around the umbilicus. She worked at general housework all morning. She took salts, which made her vomit. She went to bed at 2 P.M. Six enemas were administered, but they had no effect. The next day (Dec. 28), the patient was sent to the Episcopal Hospital.

On admission it was learned that the patient is married, has had two children, the last five years ago. For several years, and until five years ago, had almost constant indigestion, which was attributed to rich food. No indigestion for last five years. Never seriously ill before.

Examination.—Temperature 101° F.; pulse 124; white blood-cells 15,000. Abdomen distended all over and rigid, but especially on right, and more so in upper than in lower quadrant. Very tender everywhere, including *both flanks.* Dulness in right flank. Liver dulness extends a little higher than normal. On percussion, stomach is found distended, and transverse colon is at level of navel. Has not vomited since taking salts the previous morning. No bowel movement since illness began.

Operation.—Forty-four hours after onset of illness an incision was made through the right rectus, above the navel; free pus was revealed on incising the peritoneum. The incision was enlarged up to costal margin; more and more pus kept coming from right flank and from above the transverse colon. Gall-bladder distended, but otherwise normal. Lymph around cystic duct, pylorus, and on anterior wall of stomach. When field of operation was almost dry, suddenly there came a new flood of pus from above the right lobe of the liver, just beneath

the diaphragm; this pus was full of flakes of lymph. When it was all sponged away, the margin of the ruptured adhesions which formed the subphrenic abscess could be clearly seen on the convex surface of the liver. Counter-incision was made for drainage just above the tip of the twelfth rib, and a split rubber tube, filled with gauze, was passed from the abdominal to the lumbar incision. Sand pillow was now placed under lumbar spine; palpation showed no abscess of liver, no opening in diaphragm (as from empyema), no signs of psoas abscess, or caries of spine. Further search along cystic duct, duodenum, and stomach showed no perforation. Finger passed through adhesions around foramen of Winslow showed no pus or gastric contents in lesser peritoneal cavity. Right flank and gall-bladder region remained dry. Gauze drain placed to neck of gall-bladder. The appendix was found on outer side of cæcum, pointing up to flank; it felt very hard and thick. It was acutely flexed on itself about its middle, and its distal half was gangrenous and perforated. Its base was delivered, ligated, divided, and carbolized, but not buried in cæcum; meso-appendix then ligated, and appendix removed. The raw surface left on the ascending colon, between the wide-spread layers of divided meso-appendix, was partly covered in by sutures. Omentum was scanty and *very slimy*. Glass tube showed the pelvis full of pus. Pelvis was drained by glass tube through suprapubic stab wound. Main incision in right rectus (about six inches) closed in layers except at middle, where drains emerged. Time, one hour. Condition good at end of operation.

Head of bed raised, and continuous proctoclysis ordered. December 29: temperature 98.8° F. Abdomen not rigid. No vomiting. A little tearing pain now and then. December 30: temperature 99° F. Doing well. December 31: temperature rose to 101° at 8 P.M. No abdominal symptoms. January 1: temperature 105° F., patient dying. Glass tube replaced by rubber, and new gauze wick inserted beneath liver. No cause found for symptoms. Death at 2 P.M., nearly four days after operation.

Exploration of wound after death showed no pus in upper right quadrant. Lymph and adhesions beneath transverse mesocolon to left of origin of jejunum, showing the peritonitis to have been very wide-spread at one time. Most of jejunum and ileum were entirely normal. Stump of appendix in good condition. No

perforation of stomach or duodenum; gall-bladder normal. Lesser peritoneal cavity shut off by adhesions and not affected. Drainage tube to pouch of Douglas had drained it perfectly dry; there was no pus at all in the pelvis, but a loop of lower ileum was adherent to uterus and bladder, and an abscess containing several ounces of pus had formed between these *in front of uterus*. This was a space which had not been drained. Death evidently occurred from a terminal infection arising in this abscess.

The attack evidently started as an acute appendicitis, pus forming in right flank and pelvis, and extending from right flank to subphrenic region, and from pelvis to left flank and general peritoneal cavity.

II. APPENDICITIS FOLLOWED AFTER SIX MONTHS BY SUBPHRENIC ABSCESS.

Orion L., age 17 years, was admitted to Dr. Davis's service in the Episcopal Hospital March 23, 1908, with a history of being ill for three days with appendicitis. Had a similar attack one year ago. When admitted he had a temperature of 103° F., and a pulse of 128. Abdomen was rigid in right iliac and suprapubic regions, and extremely tender in both places. Not tender in either flank. No mass, no dulness.

Operation, 9.20 P.M. (on third day of illness). Transverse incision (G. G. Davis: *Trans. Phila. Acad. Surg.*, 1906, viii, 160), two inches; on opening peritoneum free pus was found, with no adhesions. Appendix delivered. It was short, subcæcal, much twisted on itself, perforated at its tip, and there was a concretion loose in the abdominal cavity. Appendix removed, stump ligated, and buried in cæcum. Cæcum friable and spotted with lymph. Omentum not seen; glass tube and gauze drain to pelvis. Another gauze strip to right flank, as there was pus here also. In all, seven or eight ounces of pus were evacuated. No record of culture. Inner half of wound closed in layers. Time of operation, 20 minutes.

The appendix was gangrenous, and contained, in addition to the concretion which had escaped from the perforation at its tip, also another concretion, with a stricture each side of its bed; the thickness of the walls of appendix gave evidence of the former attack. Patient kept sitting up in bed, and given

continuous enteroclysis. Subsequent wound healing uneventful.

April 2 and 3: slight fecal discharge from wound. April 22: up in wheel chair. On May 2, was discharged; wound firm, only superficial granulating area.

Sept. 26, 1908, he was re-admitted to Dr. Deaver's service, Episcopal Hospital, complaining of pain in abdomen and right side. In July (two months after discharge) began to have pain in back, especially over eleventh right rib, in posterior axillary line. Pain was considered rheumatic. It has continued to the present. Liniments and belladonna plasters were tried but without effect. Two weeks ago began to feel worse, and confined to bed for last week; several sweats at night, and one chill. Pain in back increased and began to affect abdomen. Was treated for malaria.

He was emaciated, sallow looking; temperature 104.2° F.; pulse 112; respiration 26. A bulging, tender area over lower right ribs, in posterior axillary line. Scar of appendix operation firm, no hernia.

Operation, Sept. 26, 1908, Dr. Deaver: Incision in tenth intercostal space opened into abscess extending between liver and diaphragm, and along thoracic and abdominal walls down to cæcal region. Drain: two rubber tubes, one to cæcum, one between liver and diaphragm. Culture of pus negative. October 2: tubes removed. October 8: temperature normal. October 10: in wheel chair. October 19: discharged.

III. APPENDICITIS COMPLICATED BY VOLVULUS OF SMALL INTESTINE.

Beatrice T., age 13 years, was admitted to Dr. Frazier's service in the Episcopal Hospital, Dec. 22, 1907, with a history of an attack of acute appendicitis of one week's duration. On admission she presented a peritonitic facies, sweet smell to breath. Fecal vomiting. Has passed mucus, but no blood by rectum. Temperature 98° F.; pulse 128; white blood-cells 12,400. Abdomen is very much distended, tympanitic everywhere except in right iliac fossa and right flank, where note is dull; no change in level of dulness on change of position of patient. Too much distention to feel any mass. Not rigid, not very tender. By rectum finger feels hard and very tender mass in Douglas's pouch. Lungs negative; slight systolic murmur at apex of heart.

Operation, 3.40 P.M. (one week after onset of illness). Etherized while abdomen was being prepared. Percussion of hypogastric region now gave *succussion splash, i.e.,* fluid in air-containing cavity. Incision through right rectus close to median line: omentum presented, adherent to mass of intestine; omentum was full of distended veins, dark yellow and dull. Gauze packs placed. Appendix when delivered was found gangrenous and perforated about one inch from base. Stump ligated, divided, and carbolized, but not buried in cæcum. Glass tube to pelvis gave about one ounce of bloody seropus. Felt many obstructing bands, and found gangrenous small intestine; delivered this, and found a clockwise volvulus of ileum, which was untwisted by giving it one and a half turns in a contra-clockwise direction. This was the gut that was full of fluid and air and that gave succussion splash; it occupied the pelvis, and was the tender mass felt by rectum. The small intestine which occupied the right flank, outside of ascending colon, was also dark blue, distended, and sloughing in spots. Eventration of affected small intestine, with constant hot saline irrigation; this resulted in some improvement in color of highest loops of ileum. Next found collapsed bowel, and traced it up to lower end of distended portion, clamped and divided it, and resected four and a half feet of gangrenous ileum. To relieve distention above region resected, a glass tube was passed up lumen of bowel, as recommended by Monks, emptying upper coils of jejunum of gas and fæces, and thus rendering easier their return to abdomen. Then sutured the divided ends of gut to each other and end on into the wound, making a false anus *en canon de fusil.* Time, 1 hour and 15 minutes.

Patient died about half an hour after return to bed.

IV. APPENDICITIS FOLLOWED BY VOLVULUS OF SMALL INTESTINE.

Frank G., age 16 years, was admitted to Dr. Frazier's service in the Episcopal Hospital, Dec. 7, 1909, with a history of acute attack of appendicitis of over two days' duration. On admission his temperature was 100° F.; pulse 110; white blood-cells 11,600, with 77 per cent. polynuclears. Abdomen showed small mass close to anterior superior spine of ileum, the rest of abdomen being soft.

Operation at noon (56 hours after onset of attack). Trans-

verse incision of G. G. Davis, three inches long, opening healthy peritoneum on median side of mass. Gauze pads introduced. Light adhesions around cæcum, and gangrenous appendix lying posterior to cæcum; no actual pus. Appendix gangrenous, and had a small perforation on its mesenteric border. Meso-appendix ligated with chromic catgut and divided. In attempting to deliver appendix, it pulled off cæcum, owing to gangrenous state. Stump of appendix at once clamped (no extravasation of fæces), ligated, and buried in cæcum; one bleeding point near ileocæcal valve controlled by separate suture. Cæcum had flakes of lymph on it. Glass tube was passed to pelvis, and a few drachms of thin pus were withdrawn. Culture of pus reported "numerous bacteria, *mixed.*" Drains: glass tube to pelvis, one strip of gauze to stump of appendix, and one to hold small intestine away from incision, inner half of which was closed. Time of operation, 30 minutes.

Patient kept sitting up in bed, and given continuous proctoclysis.

December 8: temperature normal; pulse 100. Given some water early this A.M.; vomited at 8 A.M., after some abdominal pain. Abdomen a little distended in epigastrium. Two ounces of pus from glass tube.

December 9: vomited again. Occasional sharp pains. Rubber tube inserted in place of glass. Epigastrium more distended; no flatus by rectum. Temperature normal; pulse 96–110. Two enemas in evening gave fair bowel motion, very little flatus. *No peristalsis can be heard.* Diagnosis: paralytic ileus. Ordered eserin, grain one-sixtieth, at 3 and at 6 P.M. Gastric lavage relieved distention.

December 10: vomited again, bile only. Examined by Dr. Neilson, who concurred in diagnosis of paralytic ileus, and who advised salts in lavage fluid. No flatus was passed. Soon after this examination, peristalsis could be heard, and just after giving next lavage patient vomited some upper intestinal contents. Examined by Dr. Deaver, who diagnosed mechanical obstruction and advised operation. White blood-cells 29,600, with 86 per cent. polynuclears.

Second operation, 5.30 P.M. (53 hours after first operation). Ether. Reopened transverse incision; pus between skin and sheath of rectus, edges of drained portion of wound were green; all parietal peritoneum of iliac fossa was gray-green; tube

draining pelvis well. Lower ileum collapsed. No cause for obstruction found here. Median incision, from left of umbilicus to pubes; no diffuse peritonitis; upper and left abdomen full of distended coils of small intestine; nothing else seen. Delivered six to eight feet of distended gut, and could then see collapsed ileum; picked it up, determined its direction, and traced it upward. Found that loops of distended gut had twisted around this collapsed gut in a contra-clockwise volvulus. Reduced this volvulus by one full turn in clockwise direction. Tracing collapsed gut higher, found three distinct kinks in loops of ileum lying in pelvis, the adjacent limbs held tightly together, and entirely occluding lumen. Almost gangrenous in spots. Kinks separated, and rent in mesentery sutured. Constant hot irrigation over eventrated bowel. Iodoform gauze wick placed over sloughing area; intestines replaced in abdomen; large rubber tube to drain pelvis; wound closed with through-and-through sutures. Time of operation, 45 minutes.

During operation received one pint and a half of saline solution intravenously; was very badly shocked. Stomach washed out again at end of operation. Returned to bed in exceedingly restless condition, and died 26 hours later, on the fifth day after first operation.

Dr. Ashhurst added that cases such as these represent a fair proportion of the emergency work of a large hospital. Although only one of the patients recovered, a discussion of certain of the features of the fatal cases might prove of interest.

Cases of appendicitis may be grouped for clinical purposes thus: 1. Uncomplicated appendicitis, either acute or in the interval. 2. Appendicitis with abscess. 3. Gangrenous appendicitis. 4. Appendicitis with diffuse peritonitis (no adhesions). 5. Appendicitis with multiple abscesses (numerous adhesions). 6. Appendicitis with intestinal obstruction.

Almost invariably a patient when first seen will fall quite unmistakably into one or other of these groups. The first group is the least serious, and the mortality is less than 1 per cent. The other groups represent cases progressively worse, and the mortality under any kind of treatment rises by leaps and bounds. These groups are not mentioned in pathological sequence, but in the order of their clinical gravity. Many cases of appendicular abscess have passed through the stage of diffuse peritonitis, operation having been delayed purposely or through ignorance.

But not all cases of diffuse peritonitis are converted into the less serious class of appendicitis with abscess; a large proportion of them pass over into the form of peritonitis with multiple abscesses, and from this, or without passing through the intermediate fifth group, they become complicated by intestinal obstruction. It is on account of this uncertainty as to the course which cases of diffuse peritonitis are going to pursue, that Dr. Ashhurst does not favor the treatment advocated by Ochsner, of treating all such patients by gastro-intestinal rest and postponing operation until an abscess forms; because in a number of cases no localized collection of pus will occur at any time, but either multiple abscesses will develop or intestinal obstruction will occur, or the patient will die of septicæmia or a terminal infection before relief is afforded by operation.

The first case reported belongs to the fifth group, that of appendicitis with multiple abscesses, the patient having had, in addition to the subphrenic abscess, pus widely diffused in her abdomen, including the pelvis, both flanks, and the region beneath the transverse colon, as shown at autopsy. The second case, with volvulus which occurred before operation was undertaken, belongs to the sixth group. Both these patients could almost certainly have been saved if operation had been possible at an earlier stage of the disease. It is very much more usual for subphrenic abscess or intestinal obstruction to arise some time after an operation than for operation to be postponed until they are present; and when occurring after operation the prognosis usually is much better.

Probably the most complete statistics of subphrenic abscess are those of Lance (*Gaz. d. Hôp.*, 1909, lxxxii, 63, 99), who collected almost a thousand cases, analysis of which confirms the figures published by others, showing that about 20 per cent. are caused by appendicitis; 30 per cent. are caused by lesions of stomach and duodenum; 13 per cent. are caused by lesions of liver and gall-bladder; 37 per cent. are caused by lesions of pancreas, spleen, large intestine, pleura, etc.

In regard to subphrenic abscess caused by appendicitis, Lance estimates that it occurs in 0.5 per cent. of cases of appendicitis of all kinds, and in 3 per cent. of cases of suppurative appendicitis. In about two-thirds of the cases it occurred some time after operation, usually in cases of appendicitis with localized abscess. He found only 10 cases recorded in which the sub-

phrenic abscess was a primary development in connection with general peritonitis (as in the first case recorded herewith); and in most of these cases no operation was done, the condition being discovered only at autopsy. Lance found that empyema exists in about 60 per cent. of post-appendicular cases of right-sided subphrenic abscess.

Nearly all cases of subphrenic abscess which follow appendicitis are right-sided. Among 106 cases studied by Eisendrath (*Jour. Amer. Med. Assoc.*, 1908, i, 751), only six were left-sided abscesses; and in the large majority of cases the infection spreads by continuity, invading first the right renal pouch, then the right posterior intraperitoneal subphrenic space, including the subhepatic space, and finally reaching the right anterior subphrenic space around the free margin of the right lateral ligament of the liver.

As pointed out in Barnard's admirable lectures (*Brit. Med. Jour.*, 1908, i, 371, 429), the diagnosis is based on the *history of the case,* the *character of the onset,* the *signs of pus in general, abdominal signs and symptoms, thoracic signs and symptoms, localizing signs,* and, as a last resort, *aspiration.* In the first case reported it does not seem likely that a more accurate diagnosis was possible than was made: there was undoubtedly diffuse peritonitis, and with a history of indigestion, and most marked symptoms pointing to the upper right quadrant, the gall-bladder or upper digestive tract appeared more likely to be the cause of the trouble than the appendix. In the second case, however, not only was there the previous history of an operation for appendicitis with diffuse peritonitis, but there were very positive localizing signs (bulging, tenderness), which rendered diagnosis easy.

The treatment naturally consists in the evacuation of the abscess; and the incision may be anterior, posterior, or lateral. Lateral incisions are seldom advisable, being suitable only where the abscess is manifestly pointing in the axillary line. Anterior or abdominal incisions are employed in cases of exploration, where the diagnosis is uncertain, and are to be preferred in all cases complicated by diffuse peritonitis, as in the first case recorded herewith. It usually is advisable to make a counter-incision in the loin, for drainage. In the great majority of cases of subphrenic abscess, however, which conform rather to

the type of Case II, where the abscess is of slow formation, and where a positive diagnosis is made before operation, the posterior transpleural or subpleural route is preferable.

Volvulus appears to be more frequent in the small than in the large intestine, contrary to the classical teaching; at least in his own experience, which includes four cases of volvulus (two in connection with a Meckel's diverticulum, and the two just reported), there has not been one case in which the colon was affected. At the March meeting of the Academy, Dr. Hodge (ANNALS OF SURGERY, 1910, ii, 271) presented statistics as to the frequency of volvulus, reporting 1 case of volvulus among 61 cases of intestinal obstruction at the Presbyterian Hospital during the last decade, and 7 cases among 57 operations for intestinal obstruction at the Pennsylvania Hospital. Dr. Ashhurst's own experience with intestinal obstruction (apart from strangulated hernias and congenital deformities) embraces only 10 operations, yet 4 of these were caused by volvulus (Case IV, recorded herewith, also presented kinks).

Volvulus seems to be a rare complication of appendicitis, especially when arising before operation. Le Conte reported (ANNALS OF SURG., 1905, i, 148) a case of volvulus of the small intestine occurring two months after appendectomy, which he successfully treated by operation four days after the first symptoms, which commenced mildly; but as there was no mesenteric thrombosis in the affected bowel, he thought the volvulus could not have arisen more than a few hours before operation. When the bowel is gangrenous, as in Case III of the present series, there is nothing to do but resect it; and if the portion removed is high in the intestinal tract, and the patient's condition warrants it, an end-to-end anastomosis should be done; but in cases, as in the present instance, where it is necessary to terminate the operation rapidly, it is better to establish a false anus.

In Case IV, an earlier diagnosis might have enabled the patient's life to be saved. But the differential diagnosis between mechanical and paralytic ileus, while easy in theory, is not always so in practice; and in the absence of projectile vomiting, with no evidence of peristalsis, and with a minimal amount of pain, the existence of mechanical obstruction was not determined until the third day after operation, when pain, peristalsis, and projectile vomiting became noticeable features of the

case. Yet on opening the abdomen it was clear that obstruction must have been complete for 24 hours at least.

The *technic of the operation for intestinal obstruction* is one of the least regular and typical known to surgery, and this is perhaps one reason why so few patients are saved by it. It is an accepted fact that it is undesirable to eventrate the distended bowels, and that the collapsed bowel should be sought and traced upward. To find the collapsed bowel it is recommended first to locate the cæcum or transverse colon; if these are distended, the obstruction must be still lower. But in a great many cases, as in Case IV, the distention of the bowels is so great that it is perfectly impossible to see anything else, or even to introduce the hand for search, until the distended coils are removed from the abdomen. But as soon as they are relieved from the pressure of the abdominal wall they become still more distended, and the difficulty of their replacement momentarily increases. Moreover, if we are to believe the physiological researches of Henderson, the acapnia induced by means of these distended bowels greatly increases the shock. In Case III, the use of a glass tube passed up the lumen of the bowel toward the duodenum, as recommended by Monks, quickly relieved the distention and considerably facilitated the return of the intestinal coils to the abdomen. It was not found possible, however, to crowd more than about two feet of intestine upon the tube at one time; but this was sufficient for the purpose in this case. It has been suggested by C. A. Morton (*Brit. Med. Jour.*, March 13, 1909) that the coils of small intestine are not paralyzed by distention so easily as they are thought to be; he holds that kinking prevents the various loops from emptying themselves into one another, and contends that if kinks were absent a single opening in the small gut would be as efficient in emptying it throughout its entire extent as is a single opening in the colon in relieving distention of the entire large bowel. But the difficulty of overcoming the kinks remains, and several attempts with Monks's glass tube method have not enabled the speaker to overcome the difficulty entirely; the most that it has done has been to promote euthanasia.

Finally Dr. Ashhurst said he should like to secure an expression of opinion from the Fellows of the Academy as to the value of eserin in paralytic ileus. There has sometimes been a suspicion in his mind that its employment has produced mechan-

ical obstruction, by rousing violent peristalsis; and he paraphrased a saying of his father's, that the patient is not sick because his abdomen is distended, but his abdomen is distended because he is sick.

Dr. John H. Gibbon, in regard to Dr. Ashhurst's question relative to the use of eserin, said that if there is a mechanical obstruction in the bowel it will do harm, because it is like giving a laxative or purgative to stimulate peristalsis in a strangulated hernia. If one could only say which cases were and which were not mechanically obstructed one could better gauge the use of eserin. Personally, he thought that most of the obstructions after operation are due to some mechanical cause, and in them, therefore, eserin, or anything of a like nature, is apt to do more harm than good.

Dr. John H. Jopson said that he reported last spring before the Academy three cases of subphrenic abscess following appendicitis out of seven or eight subphrenic infections which he had had in his own practice.

With regard to the case reported in which the subphrenic infection was present at the time of operation, he thought it a very unusual one, in that the case was operated upon when the infection had reached the abscess stage. In these cases which are now subjected to the Murphy treatment, it would seem that subphrenic abscess occurs more frequently than formerly, although he did not mean to say that this was due to the Murphy-Fowler position. Formerly they died of peritonitis before it had time to develop. These abscesses are oftentimes overlooked and cases dying with high temperatures and with collections of pus under the diaphragm are often looked upon as cases of peritonitis elsewhere.

With regard to the location of the appendix in these cases, in two of his cases it was retrocæcal and very high, and in one of these cases he made a counter-opening in the back in order to avoid a subphrenic infection, but unsuccessfully.

As a point in diagnosis, the presence of symptoms of pulmonary infection, subcrepitant râles, and diaphragmatic pleurisy is of great value in making the diagnosis in the early stage. The presence of râles as a frequent symptom was doubted by Barnard in his classical paper, but it is an important diagnostic symptom.

Dr. George P. Muller, with regard to the use of eserin

in intestinal ileus, remarked that he had had brilliant results in a few cases with it. These were, of course, cases of adynamic ileus, generally due to extensive handling of the intestines, especially in placing gauze pads for pelvic operations. He usually tried eserin in any case of intestinal obstruction where he was not sure that it was mechanical in origin. He uses large doses and gives in addition the alum enema as recommended by Dr. Murphy. He did not wish to be understood as advocating delay in the surgical treatment of cases of intestinal obstruction, but wished to state that his experience with eserin in suspected cases of paralytic ileus had been on the whole extremely satisfactory. The advantage of giving eserin at hourly intervals for three or four doses lies in the fact that, unlike medicinal purgatives, it does not increase the fluid content of the intestines but acts by stimulating the muscle of the bowel.

Dr. Morris Booth Miller said, with regard to the use of eserin, that he agreed with Dr. Gibbon that disappointment often attends its use. He had, however, used it routinely for several years in every case where he feared post-operative ileus. He employed it as a precautionary measure, and so far had been so fortunate as not to have this post-operative complication occur. He used it, alternating it with strychnia, and thereby getting more powerful stimulation to the involuntary muscle of the intestine. With this combination one seems less apt to get the poisonous effect of the eserin.

Dr. Robert G. LeConte said, with regard to the use of eserin, he agreed with Dr. Muller. He used it frequently in cases that develop distention after abdominal operation, with the belief that if it does no good it at least can do no harm, and it may perhaps permit of a diagnosis of obstruction due to mechanical causes to be made sooner than without its use. If it is not effective, it will make the vomiting more obstinate, which may lead to operation the sooner. As Dr. Muller says, it does not increase the contents of the intestines and in that it has marked advantages over the purgatives.

Dr. Astley P. C. Ashhurst, in closing, said he was not partial to the use of eserin. In the case reported it had seemed to rouse so much peristalsis as to cause obstruction. In another case, after operation for typhoid perforation, the abdomen was immensely distended, eserin was given; the man had another perforation, and died.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY.

Stated Meeting, held at the Presbyterian Hospital, October 26, 1910.

The President, Dr. Ellsworth Eliot, Jr., in the Chair.

DECORTICATION FOR POLYCYSTIC KIDNEY.

Dr. Eliot presented a woman, 28 years old, who was admitted to the Presbyterian Hospital in June, 1910. The history she gave was that about six years ago she accidentally discovered a lump in the right flank; this had gradually increased in size, and had given rise to a dull, aching pain.

Examination showed a large mass in the right flank, which was evidently connected with the right kidney. The patient was catheterized by Dr. Alfred T. Osgood, who reported that the urine from both ureters was of the same character; it was of a low specific gravity, containing a small amount of urea; no albumin nor casts, no tubercle bacilli.

A diagnosis of polycystic kidney was made, and this was verified upon exposure of the right kidney. Decortication of the kidney was done, and the wound closed. At the time of this operation, which was done about five months ago, there was no perceptible enlargement of the opposite kidney, but since then this kidney had increased in size; it was now freely palpable and evidently undergoing a similar cystic degeneration as had already taken place on the right side. There had been no change in the character of the urines from the two sides.

TRANSFUSION FOR EXTREME ANÆMIA IN AN ADULT.

Dr. Eliot presented a man, 54 years old, a commercial traveller, who was admitted to the hospital on April 12, 1910, with the diagnosis of progressive pernicious anæmia. His family history was negative, and there was nothing in his personal history that had any bearing upon his present illness. He stated that for two years he had suffered from nervousness, loss of appetite, and weakness, with intermittent attacks of jaundice. For the previous four months there had been œdema, spreading

from the ankles to the legs, thighs, genitals, hands, and face. There was frequent urination. He had been confined to bed for seven weeks, and for one week had vomited blood daily. He was very short of breath.

Upon admission to the hospital the patient was cachectic, emaciated, nervous, and depressed, and the skin everywhere showed evidence of jaundice. There was a systolic and presystolic murmur at the base of the heart. The abdomen was full, tense, and more prominent on the right side. The spleen was enlarged and palpable. The urine contained a trace of albumin and indican, with hyaline and granular casts. A blood test showed 800,600 red blood-cells, with 25 per cent. of hæmoglobin, the blood picture being typical of pernicious anæmia. The stools contained no ova nor parasites.

During the patient's first twelve days in the hospital he gradually grew worse. He became more dyspnœic and nauseated, and had a corpse-like appearance. Transfusion was done on April 25. At this time his condition was such that he was entirely unconscious of the operation, and for three days afterward he had no recollection of events that were transpiring. From that time on he began to improve very rapidly. His dyspnœa and nausea disappeared, his heart action improved, and his color became practically normal. An examination of the blood, made on April 30, five days after transfusion, showed 60 per cent of hæmoglobin, with 3,032,000 red blood-cells. On May 31 the hæmoglobin had increased to 85 per cent., and the red blood-cells numbered 4,296,000.

When the patient left the hospital on June 1 he was apparently cured. He went to the Delaware Water Gap, where for a month his improvement continued. Then he began to lose appetite and strength, and again became jaundiced. When he returned to the hospital on October 23, he was again very anæmic, and a blood test showed 40 per cent. of hæmoglobin and 1,210,000 red cells. Dr. Eliot said that a second transfusion would probably be made, but he doubted whether it would be of any permanent value.

TRANSFUSION FOR PERNICIOUS ANÆMIA: TWO CASES.

Dr. George Woolsey presented two patients. The first was a man, 54 years old. He was born in the United States, married, an artist and teacher by profession. He was admitted to the

Presbyterian Hospital on May 27, 1910, with the diagnosis of pernicious anæmia.

The patient's present illness dated back three years, when he began to suffer from dyspnœa, vertigo, cough, and occasional epistaxis. There were numbness and œdema of the extremities, with increased frequency of urination. Two years ago he was an inmate of the hospital for some time, and since his discharge he has never been strong, and is easily exhausted. For the past year his ankles have been swollen, with the formation of ulcers over the tibia.

Upon admission to the hospital the patient was very pale, but not emaciated. He appeared weak and dyspnœic, but not cyanotic. The heart was slightly enlarged to the left; the heart sounds were faint but regular, with a systolic murmur at the apex. A blood test showed 14 per cent. of hæmoglobin, with 924,000 red cells and 6,000 white cells. On September 22 a blood test gave about the same results, the picture being typical of pernicious anæmia. At this time an attempt was made at transfusion by the vein-to-vein method, but this had to be abandoned, as the blood-pressure in the patient's vein, which spurted on the proximal side, was higher than that in the donor's. This would have caused the blood to flow in the wrong direction, and the donor would have received the transfusion instead of the patient.

On September 27 another donor was secured, whose blood was tested for hæmolysis and agglutination with that of the patient, and a successful artery-to-vein transfusion was done. Immediately following this the patient's color improved greatly and the hæmoglobin rose to 30 per cent., but late that night he had a chill, followed by a temperature of 104.6°, and he became irrational. An examination of his blood showed the presence of very numerous malarial plasmodiæ, and they were also subsequently found in the blood of the donor, although he had never before given any symptoms of malaria. Dr. Woolsey said this was at least one example of the transmission of malaria where the mosquito did not act as the host.

The patient's malaria symptoms disappeared under the administration of quinine, and at present his general condition is improved, but he is very little better than before the transfusion. His blood at present shows 30 per cent. of hæmoglobin, with 3,172,000 red blood-cells, but is still typical of pernicious anæmia.

Dr. Woolsey's second case of pernicious anæmia in which transfusion had been done was a woman, 35 years old, a laundress. She was a native of the United States, married, and was admitted to the hospital on September 21, 1910. Her family history was negative; the patient herself had been nervous and moderately alcoholic, and had never enjoyed robust health. Her menstruation had been irregular, and the flow insufficient.

Her present illness began about a year ago with indigestion, weakness, and vomiting. There was some swelling of the legs, but no symptoms of cardiac trouble. There was increasing pallor; her menstrual periods became very brief, with scanty flow. When the patient was admitted to the hospital she had a death-like pallor, but she was not emaciated and there was no dyspnœa. She was more or less irrational. The heart sounds were faint, and there was a soft, blowing, systolic murmur at the apex and a diastolic murmur in the pulmonic area. The spleen was not enlarged. A blood count showed 13 per cent. of hæmoglobin, 710,000 red cells, and 3200 white cells, with 18 per cent. of polymorphonuclears and 74 per cent. of lymphocytes, the blood picture being characteristic of pernicious anæmia. The urine showed a faint trace of albumin; the fæces contained no ova nor parasites.

After discharging two or three would-be donors whose blood hæmolyzed or agglutinated that of the patient, a satisfactory donor was found, and as the patient was evidently losing ground, she was transfused on September 29, 1910. Following this there was an immediate improvement, both in her color and mentality. A blood test at the end of the transfusion showed 45 per cent. of hæmoglobin. On October 4 this had increased to 62 per cent., with 3,630,000 red cells, 7300 white cells, polymorphonuclears 92 per cent., and lymphocytes 6.3 per cent.

Since the transfusion in this case, Dr. Woolsey said, the improvement in the patient's condition had steadily progressed. Her color was now good, and the last blood test, made on October 17, showed 59 per cent. of hæmoglobin and 2,976,000 red cells, which were normal, showing no appearance of pernicious anæmia. She sits up in a chair and walks a few steps.

In both cases a few ounces of blood were allowed to flow from patient's vein before the transfusion was started.

It has been stated by Crile and others that transfusion is

contraindicated in pernicious anæmia, but the clinical evidence of this assertion is neither great nor sufficient. These two cases are too recent to indicate any permanent result, and it remains to be seen how long the improvement lasts. But even if temporary improvement, as great as in the last patient shown, can be obtained, the transfusion is worth while.

Dr. Charles H. Peck said that the result of the transfusion in the second case shown by Dr. Woolsey was remarkably good, in view of the fact that the case was apparently one of true pernicious anæmia. In view of the evidence that the condition of the woman's blood was steadily improving, a permanence of the cure might be hoped for.

EXSTROPHY OF THE BLADDER.

Dr. Woolsey presented a boy, three years old, who was admitted to Bellevue Hospital on April 19, 1910. He was born at full term with an exstrophy of the bladder, for which he had been operated on three times by the family physician, but his condition had remained practically unchanged.

At the time of his admission to the hospital, the boy was fairly well nourished. In the suprapubic region there was a bulging, red, moist surface, about an inch and a half in diameter, extremely tender and bleeding readily. It was surrounded by scar tissue, and continuous with its lower margin could be seen the urethral groove continued on the dorsal surface of a rudimentary penis. The ureteral openings on the mucous surface emitted urine periodically. The symphysis was open.

On April 21, 1910, Dr. Woolsey made a median incision, two and a half inches long, encircling the exstrophy below and carried through the peritoneum above. After inserting a probe into both ureters, the ureteral orifices with the surrounding and connecting mucosa of the trigone were dissected free from the rest of the mucosa of the bladder. The ureters were dissected free for about two inches. Calculi were detected in both ureters; they were thereupon incised longitudinally, and two large calculi were removed from the right ureter and five from the left. These calculi were facetted by contact with one another. The wounds in the ureters were then sutured with fine catgut. The upper sigmoid was then clamped off, and the isolated area of bladder mucosa containing the ureteral openings was sutured into an inch and a half longitudinal incision along the free

margin of this part of the sigmoid. These sutures of fine catgut were then reinforced by a row of fine silk sutures. The rest of the bladder mucosa was removed. The wound was closed in layers, and a rubber tube drain inserted at its lower angle.

The patient bore the operation well, although slight stimulation was necessary. The convalescence was complicated by the ureterotomy which accounted for a leakage of urine, at first slight and then considerable. After about ten days a fecal fistula developed. This finally closed, and then later the urine ceased to flow and was passed per rectum, rendering the movements watery.

When the patient left the hospital, on June 1, 1910, he was well with the exception of a slight, depressed, granulating area at the site of the drainage, and the fistula. This still persisted, and would necessitate a slight secondary operation. He is now able to hold his urine about two to three hours, and is continent. His general condition is much better than before.

CYSTADENOMA OF THE OVARY.

Dr. Woolsey presented a single woman, 46 years old, a music teacher, who was admitted to the Presbyterian Hospital on September 27, 1910. The patient stated that she had enjoyed good health up to three months ago, when she began to complain of a sharp, steady pain on both sides of the abdomen, which was worse on walking or standing and which sometimes radiated into the back. It also radiated directly across the abdomen, never downward. At the same time the abdomen began to swell, especially during the past two months. The enlargement was bilateral and symmetrical. She also complained of paræsthesia of the right thigh, followed by partial anæsthesia. There was considerable emaciation and a cough, with scanty mucous expectoration. No vomiting, no diarrhœa, no urinary disturbances. There was chronic constipation. Menstruation had been absent for the past four months.

Upon examination, the abdomen was found much distended, and a fluctuating mass was felt extending from the symphysis to two inches below the free border of the ribs. It was dull on percussion, soft and slightly tender. There was shifting dulness in the flanks.

Operation.—Upon incision, a yellowish, gelatinous substance,

loosely adherent to everything in the peritoneal cavity, filled the abdomen. A mass about eight inches in diameter lay in the pelvis. This was found to be composed of multiple cysts containing similar gelatinous material, and some of these cysts had ruptured, allowing their contents to escape. The mass was attached to the ovarian end of the left broad ligament. The uterus was normal. The right tube and ovary were absent, having been removed at an operation for abdominal cyst twelve years before. The left tube was normal, and the left ovary was altogether cystic. There were small gelatinous nodules on the small intestine, and on the large intestine small black papillæ-like masses, presenting the appearance of malignant peritoneal involvement.

The operation done by Dr. Woolsey consisted of removing the gelatinous material from the abdominal cavity as far as possible, and taking out the uterus and left tube and cyst. The wound was sewed up without drainage. The patient made an excellent recovery and left the hospital on the sixteenth day after operation with an apparently normal abdomen. Pathological report, cystadenoma of the ovary. The striking feature about the case was the enormous amount (many quarts) of free gelatinous material in the peritoneal cavity. This seemed to dissolve freely in hot salt solution. In spite of the generally benign nature of ovarian cystadenoma, recurrence is to be looked for here.

URETERAL CALCULUS.

Dr. Woolsey presented a man, 33 years old, a letter carrier, who was admitted to the Presbyterian Hospital on September 14, 1910, and whose present illness began six days before with cramp-like pains in the right side, radiating to the back. He had vomited once. There had been no attacks of jaundice. Urination had lately become difficult. There was a similar attack of pain each night since the onset. The patient stated that he had had a similar attack four years ago.

Upon examination, there was marked tenderness over Murphy's point. The gall-bladder was not palpable. There was also marked tenderness in the right flank. There was marked pain on striking the costovertebral angle sharply. The urine contained a faint trace of albumin. The symptoms left one in doubt as to whether there was a gall-bladder or renal condition, and in this consisted the interest in the case. An X-ray

showed a faint, indistinct shadow opposite the third lumbar spine. Hence upon operation a two and a half inch incision was made, splitting the upper right rectus. The gall-bladder was found to be normal, but a calculus was located by palpation, opposite the lower pole of the right kidney. The peritoneum was then closed, and the patient turned on his left side. A nephrectomy incision was then made over the right kidney, and the stone in the ureter fixed and raised near the surface by a strand of catgut passed around the ureter above and below it. The ureter was then opened and the stone removed. After a flexible searcher was passed through the ureter in both directions to prove its patency, the ureteral incision was closed with three plain gut sutures. A small cigarette drain was inserted down toward the ureter, and the abdomen closed in the usual manner. The patient had a rather stormy convalescence; the abdomen was quite distended for the first few days, and there was considerable leakage from the ureter for 48 hours. This was followed by a slight purulent secretion which gradually subsided, and he was discharged, cured, on the nineteenth day. The distention of the abdomen was probably due to a paresis of the colon which sometimes follows operations in the kidney. The drain may have come in close contact with the ureter, which would have accounted for the leakage. The latter seldom occurs if neither suture nor drainage is used.

Dr. Otto G. T. Killiani said that in cases of ureteral calculus where the stone was located low down, it might easily be mistaken for a phlebolite. He recalled one case where the diagnosis of ureteral calculus was based largely upon the X-ray picture, but upon operation they found a primary carcinoma of the ureter with the formation of a phlebolite. Operation was abandoned.

Dr. Willy Meyer, speaking of Dr. Woolsey's procedure of fixing the stone by placing a ligature above it, said that he also had employed this technic to advantage, especially when the stone was low down, just above the entrance of the ureter into the bladder. He had put one catgut thread above and one below the stone, around the ureter, knotting them once only, of course without any undue tension. The method gave the operator good control of the ureter and assisted materially in the extraction of the calculus, as well as placing the sutures for closure.

DR. WOOLSEY, in reply to a question as to the indications for operation, said that he was not in favor of operating in all cases, especially when the stone was located low down and of small size. Under those conditions he would wait a certain length of time, as the stone might be expelled spontaneously. In other cases, however, where the calculus was of large size, as shown by the X-ray, where painful symptoms persisted, and especially where the urine showed indications of infection, he would advise operation.

DR. CHARLES A. ELSBERG said that in quite a number of cases of ureteral calculus of small size he had succeeded in expediting the passage of the stone spontaneously by introducing a catheter into the ureter to above the calculus and injecting oil.

SARCOMA OF THE OMENTUM AND MESENTERY.

DR. WOOLSEY presented a married woman, 45 years old, a native of Ireland, who had been an inmate of the Presbyterian Hospital on four different occasions. She was first admitted on November 2, 1908, complaining of a watery, irritating vaginal discharge, with some odor. Dr. Eliot did a supravaginal hysterectomy, removing the uterus and all its appendages excepting the right ovary.

She was readmitted on July 23, 1909, suffering from abdominal distention and weight, and upon examination a mass was felt in the abdomen. On August 12, 1909, Dr. Woolsey opened the abdomen, which contained considerable bloody fluid. A tumor, about the size of a grape-fruit, elastic and very friable, was found attached to the mesentery and gut. It apparently had no connection with the right ovary, which was about the size of a small egg. The tumor was easily peeled loose from its connections and removed. The right ovary was also removed. The pathologist at this time reported that the growth was a fibroma.

On February 28, 1910, the woman returned to the hospital for the third time. She stated that she had had no symptoms, but had accidentally discovered a tumor, about the size of her fist, in the region of the umbilicus. The abdomen was reopened by Dr. Eliot, who found a mass about six inches in diameter, with an irregular, nodular surface. It was attached to the ascending, descending, and transverse colon. It was removed, together with considerable adherent omentum. The

colon was carefully cleansed of all suspicious particles; no metastases were found. At this time the pathological report was spindle-celled sarcoma.

The patient was readmitted to the hospital on July 19, 1910, with the history that four weeks prior to that time masses had been found in the abdomen on a routine examination. Four days prior to admission she had been attacked with cramp-like pains, abdominal tenderness and fever. On July 19, when Dr. Woolsey reopened the abdomen, he first encountered a number of adhesions of the gut to the old scar. To the right of these adhesions there was a large abscess filled with yellow, foul-smelling pus. Below this abscess was a tumor the size of a peach attached to the wall of the appendix, which was enlarged, thickened, and acutely inflamed. The wall of the intestine was studded with white plaques. The abscess was evacuated and the appendix and tumor removed. Following this operation, a fecal fistula developed, and there was a purulent discharge which persisted for some time, but this gradually ceased and the patient left the hospital on August 17 in apparently good health. The pathological report on the last specimen removed was spindle-celled sarcoma. The pressure of the tumor against the appendix appeared to be responsible for the appendicitis by interfering with its blood supply.

PERFORATING GASTRIC ULCER.

Dr. Clarence A. McWilliams said he had had seven patients upon whom he had operated for perforations of the stomach or duodenum, and in four that he showed the operation had proven successful; the others had died. In the latter three, the operations were undertaken within six hours, twelve hours, and three days, respectively, after the perforations occurred. The man who had been sick three days was moribund at the time of the operation from general peritonitis; the other two were admittedly exceedingly alcoholic.

Of the four cases that recovered, the first was a man, 24 years old, who was admitted to the Presbyterian Hospital on April 25, 1907, being brought to the hospital at 12.30 A.M. by ambulance. The history obtained was that for six weeks he had been having some gastric distress after eating. There was no history of alcoholism in this case. Eight hours before operation he felt a sudden, severe pain in the epigastrium, spreading

over the entire abdomen. About an hour after the onset of the pain he vomited, and this was repeated twice before the operation, which was done at 2 A.M. His temperature on admission was 100°, pulse 88. A blood count showed 20,000 leucocytes and 88 per cent. of polynuclears. The entire abdomen was rigid. There was total absence of liver dulness, the tympany reaching as high up as the fourth space. The diagnosis was not absolutely certain, but a perforation of the stomach was considered possible, and an incision was made through the middle of the right rectus high up.

Upon opening the peritoneum, a turbid, greenish, mucoid fluid escaped; it was without odor, and contained whitish masses which were supposed to be curdled milk lumps. In none of the patients with perforations of the stomach upon which Dr. McWilliams had operated had he ever detected the slightest stomach odor in the abdominal fluid. In this case, litmus paper reaction to the abdominal fluid showed neutral. The finger inserted into the intact foramen of Winslow located the perforation on the anterior wall of the stomach, just internal to the pylorus. There were no adhesions about the perforation, but the edges surrounding it were indurated for about an inch. Purse-string silk sutures buried the opening, and over this a Lembert continuous stitch was passed. Continuous salt solution irrigation of the pelvis and the region under the liver and left flank was instituted, and two cigarette drains were passed into the pelvis and one under the liver. The patient made a perfect convalescence without incident, and is in excellent health at the present time.

The second case was that of a chauffeur, 30 years old, who, one day in March, 1910, at 4.30 in the afternoon, while driving his car in the Park was seized with such an excruciating pain in the epigastrium that he had to abandon his car and was brought to the hospital in an ambulance. At 5 P.M. his blood showed 21,500 leucocytes, with 76 per cent. of polynuclears. At 6 P.M. he refused to be operated upon. At 8 P.M. his blood showed 31,000 leucocytes with 90 per cent. of polynuclears, and his pain had become so severe that he asked for operation. Examination showed that his abdomen in its upper part was absolutely board-like, so that one could make no impression upon it. There was almost an entire absence of liver dulness.

The patient was operated on at 9 P.M. A small perforation

was found on the anterior surface of the pylorus, surrounded by an immense hardened area which was thought to impinge on the pylorus. For this reason, a two-row silk posterior gastro-enterostomy was added, using the Roosevelt clamp. The abdominal cavity was irrigated with Blake's tube and the abdominal wall closed without drainage. The patient made an uneventful convalescence. Since the operation, he has had some dyspepsia, being principally due to the accumulation of gas. No vomiting has occurred.

The third case shown by Dr. McWilliams was a man, 32 years old, who was operated on May 12, 1910, for a perforation of the stomach which had occurred eighteen to twenty hours previous to the operation. His temperature at the time was 100° F., pulse 80. A blood count showed 17,000 white cells and 90 per cent. of polynuclears. The diagnosis lay between a high gangrenous appendicitis and a perforation of the stomach or duodenum. The right abdomen was very rigid, with its point of maximum intensity in the upper rectus. The rigidity extended downward over the region of the appendix, and there was marked tenderness on rectal examination. An incision through the middle of the upper right rectus opened the peritoneal cavity, with the escape of an odorless, mucoid fluid. The perforation was only visible after the separation of some adhesions, and was situated on the stomach side of the pylorus. The area of induration was about the size of a silver half-dollar, with the perforation in its centre, large enough to admit the blunt end of a lead pencil. It was easily closed by interrupted Lembert sutures of black silk. The area of induration about the perforation was so great that it was deemed advisable to perform a posterior gastro-enterostomy, which was done, using the Roosevelt clamp and continuous chromic sutures in the mucous membrane, and continuous silk sutures in the serous coats. The right side of the abdomen and the pelvis were washed out with Blake's tube, and the wound in the abdomen was closed without drainage. The convalescence was without incident. Digestion has been perfect since the operation.

The fourth case concerned a man, 28 years of age, who had had an appendix operation eighteen months previously. On May 14, 1910, at nine o'clock in the morning, he was seized with severe abdominal pain, and at 2.30 P.M., when he was admitted to the hospital, his temperature was 102°, and a blood

count showed 31,000 leucocytes and 90 per cent. polynuclears. The right rectus was exceedingly rigid. There was no decrease in liver dulness. The patient was operated on within seven hours after the occurrence of the perforation. An incision was made through the middle of the upper right rectus, evacuating a slight amount of odorless, mucoid, brownish fluid. The wound was enlarged upwards, and with the finger some adhesions were separated under the liver, letting free a large amount of odorless, bile-stained fluid. There was an enormously indurated, thickened area on the stomach side of the pylorus, in the centre of which was a perforation about the size of the blunt end of a lead pencil. This was closed with two rows of continuous Lembert silk sutures. A posterior gastro-enterostomy was added as a safeguard in case the duodenum was constricted too severely. Two rows of continuous silk sutures were used, the jejunum not being rotated but being joined antiperistaltically to the stomach. The pelvis and right side of the abdomen were irrigated with normal salt solution through Blake's tube and the wound was closed without drainage. This patient developed a small abscess beneath the abdominal scar, into which it opened. His further convalescence was uninterrupted. Since the operation he has had considerable trouble with gas.

These four cases, Dr. McWilliams said, brought up certain questions for discussion: (1) the advisability of doing a gastro-enterostomy in suitable cases, namely, those in which the pylorus was thought to be constricted; (2) the use of salt solution irrigations; (3) the advisability of drainage.

Dr. N. W. Green said in one case he found the perforation on the anterior surface of the stomach, and because of thickening, was unable to close it by inverting the edges of the opening. He therefore sewed the perforation to the abdominal wall, thus creating a gastric fistula. From experience in the Physiological Laboratory, he knew that a gastric fistula in a dog could not be kept open without the introduction of a spool. He expected a similar closure to take place in this case. The patient made a good recovery, and the fistula eventually closed. The speaker asked whether this would not be regarded as a rational procedure in cases where it was impossible to do an invagination.

Dr. Arpad G. Gerster said the question raised by Dr. Green

was particularly interesting to him, as it recalled a case which was presented to this Society some years ago by Dr. Charles H. Peck, who had operated on the patient for a perforation of the stomach following ulcer. This patient had been operated on a year or two before that time by Dr. Gerster for the same affection. He came under the latter's care at the German Hospital with the history of sudden collapse, pointing to a perforation of some abdominal viscus. A tumor was made out in the epigastrium, and upon opening the abdomen an abscess was found, the contents of which indicated that it was associated with a previous gastric perforation. In that case, evidently, nature had done approximately what Dr. Green had suggested. The ulcer had healed at a time, when there was still a point of communication between the stomach and the abscess.

Dr. Gerster said he believed that under conditions, the suggestion made by Dr. Green, namely, to convert the perforation into a gastric fistula, might prove serviceable. If the leakage were checked, the fistula would heal in the course of time.

Dr. Benjamin T. Tilton said that in cases like the one cited by Dr. Green he thought it would be wiser to cover the perforation with omentum, which would act the same as a suture in closing the opening and preventing leakage. In most of the cases in which the perforation was converted into a gastric fistula the patients had died of inanition, whereas the same purpose could have been served by sewing omentum over the opening, which could be done very quickly.

Dr. Eliot said that about two years ago, in an article on this subject by Conrad Brunner, and later, in an article by the speaker on perforated duodenal ulcer, a careful review of the literature revealed only a single instance of a gastrostomy of this kind that ended in recovery. In some twelve or fourteen other cases reported, death had occurred from inanition or peritonitis or some other cause.

TUBERCULOSIS OF THE SPLEEN.

Dr. Forbes Hawkes presented a boy, eight years old, whose previous history had been negative, excepting for constipation, until June 1, 1910. He had then suffered from an attack of gastro-enteritis, but this had not been severe enough to confine him to bed. Toward the end of June, a swelling in the ab-

dominal region appeared. The boy's mother thought that during this time he had lost slightly in weight.

On examination, the boy's throat was found to be slightly reddened, and a culture revealed the presence of diphtheria bacilli and staphylococci. A large spleen was made out, occupying the umbilical region. The blood count was normal. The patient was isolated for a few days, until the diphtheria bacilli disappeared from the cultures. He was then taken back to the ward, and kept under observation. The spleen, which had previously been movable, was then found to be distinctly less so, and tenderness appeared over it. A few days later the spleen became markedly adherent. An operation disclosed œdema of the overlying muscles, and a large, soft, granular spleen fixed to the abdominal wall. Two sections of splenic tissue were removed. The peritoneal cavity was opened above the spleen. Several omental nodules were seen where the omentum had become adherent to the spleen, and there was also one nodule on the dome of the liver. Several of these nodules were removed for examination.

The microscopic report of the sections of the spleen and the omental nodules showed tuberculosis. Cultures from the peritoneal cavity showed staphylococci. The patient did well after the operation, with the exception of a severe bronchitis, which subsided in a few days. The wound was slow to heal, and still showed a scabby area in its upper part. The patient had gained in weight and his constipation had been relieved.

The case was regarded as one of tuberculosis of the spleen, with secondary infection from the throat.

OPEN OPERATION FOR SEPARATION OF UPPER EPIPHYSIS OF HUMERUS.

Dr. Hawkes presented a boy, seven years old, who on July 5, 1910, fell from a fire escape, a distance of about twelve feet, striking on his left shoulder. He sustained what proved under the X-ray to be an epiphyseal separation of the head of the left humerus. The upper fragment was situated below the glenoid fossa. As manipulation under a general anæsthetic was ineffectual in approximating the fractured surfaces, an open operation was done. It was found that the shaft of the humerus, after its head had been fractured, had pushed its way through the capsule of the joint upwards, and presented directly under

the skin. The capsule had nipped the shaft so that bloodless reduction had been rendered impossible.

The edges of this portion of the capsule were held apart by retractors, and through this opening the projecting part of the shaft was brought down. The upper fragment was then pried back into place with a periosteal elevator, and sutured to the shaft by a chromicized catgut suture passed through holes drilled into the bones near the fractured surfaces. The edges of the split capsule were then brought together with chromicized catgut. The arm was put up in a position of moderate abduction, this being the position in which tension on the fragments seemed to be least felt.

The boy made an excellent recovery. Passive motion was begun on the tenth day, and he now has excellent use of the arm. Only slight thickening could be felt at the site of the fracture.

THE TREATMENT OF SPREADING PERITONITIS.

Dr. John A. Hartwell presented twelve cases in which there had been present extensive spreading peritonitis following appendicitis, which had come under his care during the past summer, in the Presbyterian Hospital. For the privilege of operating on them he expressed his thanks to Drs. Eliot, Woolsey, and Hawkes, of the attending staff. All these cases had been treated in the same general way, and all had recovered, so that an analysis of the conditions found and the results might be of value in deciding some unsettled points concerning them. Eight were males and four were females. The youngest was eight years old and the oldest was forty; five were children under thirteen. Nine were suffering from their first attack, two from their second, and one from his third. Five were operated upon about 24 hours after the onset of acute symptoms; one on the second day, two on the fourth day, one on the seventh, and one on the ninth. All, without exception, showed evidence of a more or less extensive peritoneal inflammation by the presence of general rigidity and general tenderness, and in four cases by dulness in both flanks. Seven cases were considered seriously sick, as judged by the pulse-rate, respiration, general appearance, and the abdominal signs. The remaining five, while giving evidence of very considerable toxæmia, could not be classed as unfavorable cases. Only

three of the entire twelve could be classed as desperate cases.

The findings with regard to the white blood-corpuscles were interesting: the leucocytosis varied from 9000 to 30,000 in the ten cases, where it was recorded before operation, and the polynucleosis from 73 per cent. to 96 per cent. There was no relation whatever between the severity of the infection, as judged from general and local findings, and either the increase in total leucocytes or polynuclear leucocytes, nor did the severity of the postoperative course seem to depend in any way upon the reactive power as shown by the leucocyte count. In the two cases, however, where the count remained close to the normal, the condition at operation was found less extensive than in the others. One man with 16,000 leucocytes and 96 per cent. polynuclear cells made a very prompt recovery, although the intraperitoneal infection was very extensive. One woman having 11,000 leucocytes with 90 per cent. polynuclears showed a severe and general peritoneal inflammation, and made a very prompt recovery. On the other hand, a man having 24,000 white cells, 80 per cent. being polynuclear, showed no evidence of being seriously sick. At operation he showed the least peritoneal involvement of the whole series, yet his convalescence was among the most severe. It seemed fair to conclude that with a spreading peritonitis, the findings as regarded leucocytosis and polynucleosis were of no value in determining either the severity of the lesion or the prognosis.

A gangrenous appendix, either in whole or part, was found to be the cause of the peritonitis in each of the twelve cases. In ten cases pus was found in the subhepatic pocket, the pelvis, and the subsplenic pocket, showing that an infection process existed in practically the whole of the greater peritoneal pouch. In one case the right side and the pelvis only were involved, and in another the pus seemed to be confined to the cæcal region and the pelvic cavity. In the latter case, the postoperative course was among the most severe, although prior to operation the man did not seem to be seriously ill. In several of the cases pus was found occupying the spaces among the small intestinal coils in the umbilical region. In five cases it was noted in the history that the peritoneal coat of the intestines, so far as could be observed, showed marked inflammation. In two, absence of such a condition was noted, and one of these was the most seriously sick of the whole series. In the remaining five no mention of this condition was made, which was pre-

sumptive evidence that the serosa did not show an inflamed condition.

The management of all the cases was practically the same, modification being made only to meet special indications. All were prepared by the emergency iodine method, and were operated upon within an hour after admission. The preparation was completed and the sterile sheets placed before the beginning of anæsthesia, which was produced by nitrous oxide and ether. The incision was made over the mass, when such existed; otherwise it was made at the usual site. The appendix was removed by simple section at the base, after ligation, and the stump was cauterized with carbolic acid and alcohol. Burial of the stump was not practised because the conditions were not favorable, and the time this would have required was a distinct loss to the patient. The presence of pus in the pelvis and right flank was determined by means of a gauze sponge. If found, the table was elevated to an angle of fifteen degrees, with the head up; the return flow syphon tube devised by Blake was connected with an irrigator of hot, normal saline solution, and after the flow was established, filling the tube, the flow was temporarily stopped and the tube introduced along the anterior abdominal parietes and then downward to the pelvic floor. On again starting the flow the syphonage immediately began, and the saline solution, mixed with pus, promptly flowed from the exit tube. This was continued until the water returned clear. The tube was then cautiously introduced in the same manner into the left mesenteric gutter, and if the return flow showed pus, the procedure was continued until that region was clean. The right gutter was then attacked, and, if necessary, the coils of intestine in the midabdominal region. These procedures always resulted in the washing of some pus into the pelvis, and this was therefore again washed out. In one case, about sixteen gallons of solution were required to complete the washing, and in many of the cases from six to eight gallons were used. This washing required some practice to get the best results: the height of the irrigator, the length of the outflow syphon tube, the slant of the table, and the position of the solid tube all needed some slight modifications in individual cases.

Another point of importance was that the edges of the wound should be held snugly around the tube so that a return flow did not take place along it instead of through the syphon. If care be exercised, the separate pockets holding the pus could

be emptied with practically no soiling of the non-affected parts, and at the conclusion the operator felt comfortably sure that no free pus remained in the peritoneal cavity. The procedure was attended with practically no shock. The time consumed by the cleansing was from three to ten minutes. A drain, usually a cigarette, was passed into the pelvis, and if necrotic tissue existed around the cæcum, a second one was inserted at that point. The abdominal wound was sutured sufficiently to guard against intestinal prolapse, and a dressing applied. The entire operation in cases where no difficulty was encountered in getting out the appendix occupied less than fifteen minutes, and the usual time was from twelve to twenty minutes. At the close of the operation a lavage was done unless it had been done for special reasons previously, and the patient was put to bed with the head and shoulders elevated either by raising the whole bed or by using a bed rest, this being determined by which position was the more comfortable for the individual patient.

The contrast between many of these patients immediately before operation and on their return to consciousness from anæsthesia was marked. The abdomen changed from a condition of board-like rigidity to a normal relaxed state, and excepting over the wound showed no tenderness to palpation. The evidence of suffering had often entirely disappeared, and it was not an unusual thing to hear the patient say within a few hours that he felt quite well.

The after-treatment was as follows: Enteroclysis by the drop method was established and continued for several hours, remitting it when the colon showed any evidence of intolerance or became over-filled. Lavage was done when vomiting was troublesome, or when gastric distention was present, often being repeated three or four times in the day. Nothing was given by mouth for 24 hours. Morphine, hypodermically, was given sparingly if the pain recurred severely. If the distention became at all marked, turpentine stupes were given, the wound being protected by rubber tissue and chloroform, and these were supplemented by turpentine, oil, ox-gall, or Epsom salts enemata, or a combination of them. Nourishment was withheld until it was demonstrated that intestinal paresis need not be feared. In one or two cases this abstinence from nourishment covered a period of four days. The first nourishment was in the form of a small amount of broth and albumin water; if this was well borne the quantity was gradually increased, and then other easily

digested articles were added, milk being withheld until the bowels were moving well and distention was absent. Cathartics were used sparingly, and usually not given until after 48 hours. As soon as the digestive functions became normal, the diet was gradually increased, and then given liberally to repair the loss of strength.

The drain was usually loosened about 36 hours after operation, and was then gradually drawn out and shortened. After four days it consisted, as a rule, of only a drain for the parietes.

Results.—All of these twelve patients recovered. Two developed a small patch of pneumonia, and one a left-sided phlebitis in the femoral vein. The remaining nine had no complications. One fecal fistula developed, and no secondary abscesses. The patients left the wards to return for wound dressings in from ten to thirty days, four being discharged in less than two weeks, and four others in less than three weeks. Many of them, including those who showed a temporary cessation of pain and distention immediately after the operation, again suffered from these symptoms, and there was no evident relation between these symptoms and the severity of the condition found at operation. The most severe case in the series, a woman who remained in a precarious condition for six days, had neither, while the least extensive case, in which the pelvis alone was involved, and one of the least sick before operation, suffered severely from both for nearly a week, but his general condition remained excellent.

Dr. Hartwell said that while twelve cases were too few to establish any advantage of the treatment used here over other methods, yet the results were sufficiently promising to have this general method tried. It was in no particular a new method, but was presented as an added link in favor of the cleansing of the peritoneum as against leaving the contained pus to be taken care of by the patient.

Dr. George D. Stewart asked Dr. Hartwell if an examination was made to determine the variety of germ responsible for the peritonitis. That, the speaker thought, had something to do with the severity of the peritonitis. He believed all would agree that cases, which in the onset looked comparatively mild, might eventually give rise to very severe symptoms.

In the ordinary operation for appendicitis it was very difficult to judge how extensive a peritonitis existed; the surgeon did

not always expose the entire abdomen if he had a reasonable hope that the pus had not spread far from the site of the operation.

The question of whether to flush or not to flush the peritoneal cavity was still unsettled. Personally, he had largely given up this procedure, preferring to wipe out the pus rather than flush it out, and he had a conviction that his results were better by the former method. Of course, most surgeons, he believed, had adopted the Murphy method of irrigation, or some modification thereof, and the Fowler position, both of which he thought were very useful.

Dr. Robert T. Morris said his experience was very similar to that of Dr. Stewart. He first began by wiping out the pus, then he substituted flushing, and now he felt that wick drainage usually sufficed. The flushing method naturally appealed to a man on account of its neatness, but he questioned its necessity in the majority of cases. He believed in making cultures from the pus, which in many instances would be found sterile. In another class of cases of general spreading peritonitis, with pus over the entire peritoneum, we found the *Staphylococcus albus* as causative factor, and that pus was better left undisturbed, because the bacilli were not at work there; they were at work in the tissues and the pus was commonly sterile. There were still other cases in which bacteria of various kinds were found in the pus, and in dealing with those cases, any successful method was a good method. Dr. Hartwell had been successful with his method and therefore it was a good method. The great *desideratum,* however, was to simplify our methods as much as possible, and if we can treat these cases successfully by capillary drainage through a small incision and quick work, it is certainly a step in the right direction. The speaker said that the latter method had been successful in his hands; it might not be successful in the hands of others. The escape of the stream by capillarity must be encouraged by frequently changing the external gauze. This mechanical point is of pivotal importance.

Dr. Irving S. Haynes said he was practically in accord with the views expressed by Dr. Morris. After an opening had been made in the abdominal wall, the intra-abdominal pressure would do the rest, and a small piece of rubber tissue carried down well into the pockets offered an exit for the pus. The speaker

said he had formerly irrigated with great vigor, but had given up the method. In addition to the rubber tissue drainage, he employed Fowler's position and capillary irrigation.

Dr. Parker Syms said he was glad to hear that Dr. Hartwell favored an immediate operation in these acute cases, irrespective of the time at which the opportunity came. That was a question, Dr. Syms said, which he submitted to this Society for discussion some years ago, and he was in favor of operating, no matter at what period of time the surgeon first saw the case.

As to the method of operating, the speaker said he believed in removing the appendix in almost every case, breaking up the pockets of pus, and supplying drainage, but he never resorted to flushing, and he had become convinced that the less the peritoneum was handled, the better for the patient.

Dr. Gerster said he would like to ask those gentlemen who operated through a small incision how they knew that there was a general peritonitis? Upon what symptoms or physical signs did they base their diagnosis or assumption? And, furthermore, how could these cases be classified as general peritonitis and included in statistics? Personally, he believed that much that had been said about the statistics of general peritonitis was worthless, because diagnosis could not be confirmed in many of the cases that had been included. The type of the bacterial infection in these cases had also been referred to, but all these features were exceedingly vague, and we simply knew that the statistics adduced by some operators were exceedingly favorable, while those of others were quite the opposite. Senn used to say he did not believe that a patient had had general peritonitis unless that patient had died. When we were dealing with a peritonitis resulting from the perforation of an abdominal viscus, we generally had a tractable disease providing the case was seen sufficiently early: in such cases it made no particular difference whether one made a small or a large incision, whether one flushed or did not flush, or how one treated them. But there was another type of peritonitis that had not been mentioned at all. For example, a case was diagnosed as appendicitis, the appendix was removed, and apparently the patient was doing well. Suddenly, after a number of days, there developed all the symptoms of shock and perforation, and the patient soon died if nothing was done and usually even after something was

done. What was the probable course of events in such a case? There was an abscess, perhaps originally communicating with the appendix, but which had become separated from it by adhesions. This abscess which was left behind continued to grow and suddenly ruptured, flooding the peritoneal cavity with a large quantity of virulent pus. Many patients who were supposed to have died of peritonitis really died as the result of phlegmonous processes in the retroperitoneal cavity that were not recognized even at post-mortem examination. Those were the cases one could not cure with flushing or without flushing. They were bound to die, because the conditions were such that the lesions were not accessible to surgical treatment.

Dr. Gerster said that in their cases of spreading peritonitis at Mt. Sinai Hospital they opened the abdomen as soon as possible, eliminated the leakage, established drainage without preceding irrigation, placed the patient in Fowler's position, and by this method saved 86 patients out of a hundred.

Dr. Willy Meyer said he thought the question of which method was preferable in the toilet of the peritoneum—whether by flushing or dry sponging—was not yet settled. Personally, he had never flushed, and his results had been satisfactory. Dr. Franz Torek, one of the attending surgeons of the German Hospital, on the other hand, had treated his cases of general suppurative peritonitis by making a long median incision, removing the appendix, searching out every possible pocket of pus, flushing as long as he thought necessary, and then closing the entire cavity without drainage, and his results had been excellent. Out of some sixteen cases, all but one or two had been saved.

Dr. Charles H. Peck said he had been following Dr. Hartwell's method for six years at the Roosevelt Hospital, and he had come to the conclusion that the factor of prime importance in these cases was to produce as little traumatism as possible, and do as rapid an operation as possible. If pus was found, for example, in the right iliac fossa and could be readily sponged out, he saw no objection to doing it, but if the pus was more generally distributed he thought it could be more quickly removed through the Blake tube with syphon return than in any other way. By the appearance of the return flow one could readily tell whether there was any pus up under the liver or in the subphrenic space or elsewhere, and it was not unusual

to get a turbid return flow from obscure regions which could not be reached by sponging. For small localized collections of pus which were readily accessible, sponging answered the purpose.

Dr. Moschcowitz, referring to the question of the various bacteria present in peritonitis, said that at Mt. Sinai Hospital cultures were made in every case, and their experience had led them to practically disregard the presence of any particular bacteria, as they had found that the streptococci, the *Bacillus coli* and the *Streptococcus aureus* gave about the same mortality, whether alone or in combination. That was the result of their experience in five or six hundred cases.

The important question to decide in connection with this subject was what was and what was not peritonitis. The methods of treatment in these cases were about as divergent as the results reported. Some surgeons did not even wipe out all the pus, while others did a radical operation, and the results were practically the same. The difference in the mortality statistics, ranging from 5 to 50 per cent., probably depended on what class of cases were included under the name of peritonitis.

Dr. Morris called attention to the fact that the *Staphylococcus albus* quickly developing over the peritoneum called out protective leucocytosis and then died, so that no micro-organism might be found, although it had protected the patient, and left sterile pus.

Dr. Hartwell, in closing, said the various speakers showed practically the same differences of opinion as were elicited when this subject was brought up for discussion some time ago.

In answer to Dr. Gerster, the speaker said he did not know whether the cases he had reported were examples of general peritonitis or not, and he had given the exact regions of the abdominal cavity where the pus was found. In all but two it was found under the liver, under the spleen, and in the pelvis. By flushing with Blake's tube it was comparatively easy to reach all the small peritoneal pockets, and the procedure only occupied a few minutes. It must, however, be done carefully, and some practice is needed to get the best results.

INTUSSUSCEPTION, WITH SPECIAL REFERENCE TO ADULTS.

Dr. Ellsworth Eliot, Jr., read a paper with this title, for which see the February issue of the Annals of Surgery.

BOOK REVIEWS.

SURGICAL AFTER-TREATMENT. BY L. R. G. CRANDON, A.M., M.D. Boston, 1910, W. B. Saunders Company, Philadelphia.

Many books dealing with the immediate treatment of surgical diseases have been written. There are also some excellent publications dealing with the preparation of patients for operations. This book occupies a third special field, that of the after-care of surgical cases. It is important because the immediate treatment has always monopolized the attention of surgical writers, and too little has been said of the after-attentions upon which the recovery or cure of the patient often depends.

This book has been written for house surgeons in hospitals and for general practitioners in communities which are not surgical centres and in which the general practitioner must assume the after-care of surgical cases. The book describes tried methods. The reader is made familiar with the details of the elevated head position. The discussion of anæsthesia is practical, although neither the tongue forceps nor the mouth gag, on page 30, will find general approval.

One of the valuable features of this book are the illustrations showing both how things sometimes are improperly done and how they should be done. The relief of post-operative thirst is well discussed. Proctoclysis and saline infusion are described in this connection. The technic of transfusion is quoted largely from Crile. The discussion of the treatment of shock is complete. The author has given the modern view of this subject, but, in his zeal to omit nothing, he has included both alcohol and strychnine. While he shows these two old friends rather scant courtesy, still they are admitted to the company of therapeutic agents.

The emergencies which follow operations, one realizes, make so large a catalogue that their discussion in a work on general surgery is difficult. In such a special work as this they may

be fully treated. Here we find discussed with fulness that is sufficient, such conditions as post-operative hemorrhage, coma, collapse, thrombophlebitis, and the various infections. Resuscitation by artificial respiration, oxygen, and electricity are described. Is it not possible that surgeons make too little use of intubation and insufflation of the lungs with oxygen or forced aeration?

In discussing diet during convalescence, the author wisely suggests that the surgeon should not attempt too much, but should give the patient a wide latitude. The patient who is reasonable knows what he likes and can take with satisfaction, and is to a large degree a specialist in his own digestion. Rectal feeding is elaborated in its technic and principles. Formulæ are given. Gavage and other forms of artificial feeding are described.

Catheterization, care of the bowels, and stomach disturbances receive practical attention. The dangers of magnesium sulphate are mentioned.

Any case of post-operative tympanites which progresses in spite of treatment should be considered operative. Delay in intestinal obstruction is far more serious than operation. Operation must usually be done while there is still some doubt as to its necessity. If it is done when there is no doubt, it is usually too late.

A chapter on bandaging describes the most useful bandages. All are effective, though not beautiful. The chapters on the treatment of operative wounds present the indications and methods of dressing. An excellent résumé of the Bier hyperæmic treatment is given. The treatment of sinuses is briefly described. In the treatment of septicæmia we again encounter whiskey and strychnine. Hæmophilia is discussed with especial reference to the use of blood-serums. An idea of the thoroughness of the book may be had from the fact that the author has included post-operative psychoses, artificial limbs, massage, and electrotherapy. A chapter on preparation of the patient for operation seems like a gratuity in a book on after-treatment and surgical convalescence.

The wisdom of the author is displayed in his statement that, "nearly all that has been said as to the value of out-of-door

life and sunshine in surgical tuberculosis applies to the healing of all wounds and to surgical convalescence in general. The much vaunted air of the Engadine is, after all, only pure air, and we need not cross the ocean to find that."

Post-operative hernia, adhesions, foreign bodies left in the abdomen, and the use of abdominal binders are briefly presented. The author speaks against the prolonged use of the binder, and quotes Abel, who showed that the abdominal swathe has nothing to do with preventing the formation of hernia.

It is something of a surprise to find in a work emanating from the cultured atmosphere of Boston, that it is the custom "to operate these infants" (page 365), when the author means to operate upon them. He operates others also elsewhere in the book.

These general subjects take about one-half of the book. The second half is devoted largely to regional surgery. This latter is the more important part. It details the after-treatment in all of the ordinary operations of surgery.

The largest chapter in the book is that on vaccine therapy. The subject is well covered. While this is properly a part of immediate rather than later surgical treatment, its importance at this period of its development is so great that any surgeon who buys a book on therapy is glad to find it. More than 170 pages are given to the subject. A series of receipts for convalescents' foods closes the book.

Dr. Crandon has written a useful book. It is a valuable supplement to the works on general and special surgery. It is practical. While it draws much from the general literature of surgery, as such a work must, it displays the judgment of an experienced surgeon. Many of the illustrations are poor. So long as publishers place upon authors the financial burden of supplying illustrations, good books with poor illustrations must be published. J. P. WARBASSE.

SURGICAL ANATOMY. By JOHN A. C. MACEWEN, Assistant Surgeon to the Royal Infirmary, Glasgow, etc. New York, William Wood & Company, 1910.

The appearance during the last few years of an unusual number of works on surgical or applied anatomy is a fair

indication of a demand for a more accurate knowledge of those structures and regions which have a peculiar interest for the surgeon.

This work consists of 478 pages, with 61 illustrations; of this number 18 are original, the remainder being borrowed from standard works.

The author divides the subject into five sections, corresponding to the five natural divisions of the body.

Section I: Head and Neck, Vertebral Column, Brain and Spinal Cord. Section II: Thorax. Section III: Abdomen and Pelvis. Section IV: Lower Extremity. Section V: Upper Extremity.

The general plan of this work is, first, a consideration of the structures as they are related regionally, and next, an estimate of their clinical values and presentation of the practical problems with which they are associated.

In a work of this character an author can scarcely hope to present many new facts. The threads with which he weaves are the products of many minds and the accumulations of many years. His chief aim must be to sift, compare, and fix the clinical values of the anatomic facts, and thus clothe them with living interest.

The author has succeeded in presenting a concise account of the anatomical facts of importance to the surgeon. There are, however, a few omissions and some commissions which are too important to escape just criticism.

The author's estimate of wry-neck is conventional and hackneyed. Gerdes has shown in connection with permanent wry-neck that the scalenus anticus is as frequently at fault as the sternomastoid and should be divided with the sternomastoid. Furthermore, division of the muscle *subcutaneously* is neither to be taught nor practised. There is no excuse for "blind" surgery in the light of modern technic.

The author in his preface explicitly states that he surveys the anatomy of hernia from the abdominal instead of from the external surface, and yet he omits to mention the one fact which elucidates the anatomy of the inguinal canal. For no adequate conception of the inguinal canal is possible without reviewing the evolution of the testicle—its formation within

the abdomen, its descent through the abdominal wall, and its final arrival in the scrotum.

There is no mention made of the important fact concerning the renal circulation first suggested by Hyrtl and later developed by Brödel, viz.: that the kidney is vascularized by two arterial systems and that between them is a non-vascular zone, along which an incision may be made through the substance of the kidney with a minimum amount of hemorrhage.

The statement of the author that "nephrectomy is generally performed through an abdominal incision" does not conform with the practice of American surgeons.

WILLIAM FRANCIS CAMPBELL.

THE RÖNTGEN RAY IN PÆDIATRIC PRACTICE. By DR. THOMAS MORGAN ROTCH. 8vo; 224 pages in the text and 264 plates. Published by J. B. Lippincott Company.

In reviewing a book that deals with a comparatively new feature in pædiatric work, it is very difficult to place a fair estimate upon it. Dr. Rotch has led us in his recent book into a field that is peculiarly his own. He has ideas and has had the ability to place them before us in an interesting as well as instructive way. The text of the book is really its less important feature; the illustrations are numerous, well selected, and withal very instructive. It is one of those books that cannot demonstrate its real value until sufficient time has elapsed to test its practicability. In other words, the present volume must "find itself" by a demonstration of the practical value of its teachings. Throughout the text we find the evidences of the enthusiasm of the writer, and the claims which are made under the influence of this enthusiasm can hardly all be borne out in practical application. It is a volume that excites thought, and any book that does that is a valuable addition to medical literature.

The real test of the value of the work done by Dr. Rotch and the saneness of his deductions will come when a large number of observers have had the opportunity to test out in practical application some of the suggestions laid down. The book should be added to the library of every pædiatrist, and it is not without considerable value to the surgeon.

LE GRAND KERR.

VARIATIONS OF THE BONES OF THE HANDS AND FEET. A Clinical Atlas. By THOMAS DWIGHT, M.D., LL.D. Parkman Professor of Anatomy at the Harvard Medical School. With 36 plates and 79 figures. J. B. Lippincott Company, Philadelphia and London.

This is a book of wonderfully clear X-ray plates. These plates show far better what the author wishes to teach than words alone could. The descriptions are clear, concise and to the point. It is not purely an anatomical study, but a very needy book for the surgeon, orthopædist and the general man as well.

By his plates he shows numerous variations in size, shape, position, and division of the bones. This has a great bearing on anatomy and surgery. The development and placing of extra bones is important. Extra bones are sometimes so placed that they simulate fracture. This is shown, and explained to one's full satisfaction. Taking one bone of the wrist—the scaphoid—the author clears up some mistaken diagnoses. This develops frequently as two separate bones and is called the divided scaphoid. This, of course, may appear under the X-ray as a fracture. The author says in regard to diagnosis of this condition: "I am far from questioning the diagnosis in many cases of fracture of the scaphoid. I do not deny that a normal bone may be broken, but strongly suspect that in most cases called fractures there was a subdivided bone to begin with." Plate 1, Fig. 2, and Plate 2, Fig. 5, show this subdivision. There are numerous other valuable points through the book.

NORMAN PHILIP GEIS.

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